SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JULY 1909.

GENERAL PHYSICS.

1155. 300-*Ton Testing Machine.* (Mech. Eng. 23. pp. 663–664, May 28, 1909.) — The machine described was constructed by Messrs. Avery for Birmingham University. The max. stretched length of tensile test-pieces is 33 ft. 6 in., max. length of compression specimens 30 ft., max. depth of girders or other transverse test specimens 30 ft., max. span in transverse tests 20 ft. Specimens are placed horizontally, and the hydraulic cylinder is at one end of the machine and the weighing mechanism, consisting of a series of three levers, at the other. The steelyard, which is the third of these levers, carries seven poise weights. F. R.

1156. *A Portable Rotation Psychrometer.* **P. J. O'Gara.** (Monthly Weather Rev., Washington, 37. pp. 22–23, Jan., 1909.)—The instrument consists of a large bevel gear provided with a crank which drives a small gear. The axis round which the small gear turns carries a light steel frame, which is revolved by the small gear after the manner of the domestic egg-beater. The wet and dry bulb thermometers are attached to the frame which is so constructed so as to protect the thermometers from accidents. R. G. K. L.

1157. *Torsion Balance as Seismograph.* **V. Crémieu.** (Comptes Rendus, 148. pp. 1161–1163, May 3, 1909.)—By constructing a special form of torsion-balance pendulum consisting of a regular-surfaced weight hung by a long thin wire, with the centre of gravity of the mass slightly displaced from the axis of the system, it has been found possible to detect variations in azimuthal displacement when the pendular motions are not perceptible. A companion pendulum with triple suspension is added to measure the amplitude of the deflection. C. P. B.

1158. *van der Waals' Equation of State and the Solid State.* **I. Traube.** (Deutsch. Phys. Gesell., Verh. 11. 9. pp. 231–236, May 15, 1909.)—The author gives a table of internal pressures, atomic volumes, compressibilities, and atomic compressibilities for a number of metals. The numbers show that, not only are the compressibilities referred to the gm.-atom parallel with the internal pressures (or co-volumes), but also the product of internal pressure and the square root of the atomic compressibility is roughly constant, the mean value being 4·04. The deviation from this mean value is greatest in the case of iron, the internal pressure of which is, however, not accurately known, as it is increased considerably by traces of carbon. The author has recently shown that if, by means of van der Waals' equation the approximate surface tensions, a/v^2, are calculated, it is found that these numbers and the electric potential-difference of the metals, and therefore the voltaic series, correspond extremely closely. T. H. P.

1159. *Tension in Elastic Body and the resulting Double Refraction.* **O. M. Corbino.** (Accad. Lincei, Atti, 18. pp. 437–444, May 2, 1909.)—The distortion of a cylindrical shell in which a radial or parallel slot has been cut, the faces being then cemented together, has been calculated by V. Volterra [see Abstracts Nos. 1674 and 2139 (1905)]. In the present paper the author suggests the use of cylinders constructed of a transparent medium (gelatine), the strain being detected by the double-refraction phenomena when the cylinder is examined between crossed nicols in a beam of light parallel to the axis of the cylinder. The shape of the isochromatic lines which would result from the Volterra strains is calculated in the two cases. **G. C. Trabacchi.** (Ibid. pp. 444–449, May 2, 1909.)—The construction of the gelatine cylinders and their examination between crossed nicols as suggested by Corbino for investigating the Volterra distortion is described. Several reproductions of the effects observed are given, and these are in strict confirmation of the calculations of Corbino and Volterra. S. G. S.

1160. *Hardness of Crystals.* **B. Halle.** (Zeitschr. Instrumentenk., Beib. 9. pp. 81–84, May 1, 1909.)—In ignorance of the work of Rosiwal (Verein zur Verbreitung naturwissenschaftl. Kentnisse, Wien, p. 605, 1898), the author designed a machine for measuring mineralogical hardness in which the weight removed in polishing the sample with a given abrasive, under a constant weight, at a constant velocity and in constant time, are observed. The principle is that of a lapidary's polishing wheel, and the specimen is made to traverse the wheel mechanically. The disc is of brass, which holds the polishing powder better than glass, which was used by Rosiwal. Emery, corborundum, and diamond powders of medium fineness are used which are moistened with water, oil, alcohol, &c., according to the nature of the specimen whose hardness is to be estimated. Results which have been obtained are promised for a future paper. F. R.

1161. *Mechanical Tests of Cast Iron.* **C. Frémont.** (Bull. Soc. d'Encouragement, 111. pp. 943–968, May, 1909.)—The results of 110 static bending tests of various cast irons show that the modulus of elasticity varies from 1/5 to 3/5 of that of steel, and in the inverse sense to the ultimate strength. This explains why tensile tests of cast iron by the usual method do not give satisfactory results, as a certain amount of bending also usually occurs. The elastic limit as measured in the bending tests occurs at from 0·45 to 0·80 of the ultimate load. A novel machine was used for the bending tests; test-pieces measuring 10 mm. × 8 mm. section × 80 mm. span were used, and the load-strain diagram recorded autographically. The ultimate loads ranged from 800 to 840 kg. Shearing tests of the same irons, by means of the machine referred to in Abstract No. 1528 (1906), showed that a well-marked straight line relation between ultimate bending and shear strength exists. When the shear strength was considerably above the mean line, the elastic limit in bending for the same iron was also high. The shear strength ranged from 8 to over 28 kg. per mm.². A good machine cast-iron should give at least 18 kg. per mm.². Shock tests of the cast irons gave very variable results. Samples which required 45 cm. drop of the 12 kg. weight (specimen 40 mm. square section) included cast irons with from 10 to 21 kg. per mm.², and those which required 60 cm. drop had shear strengths of from 12 to 20 kg. F. R.

1162. *Effect of Magnetism upon Elongation.* **W. J. Crawford.** (Nature, 80. p. 889, May 20, 1909.)—The elongation of iron and steel bars magnetised to saturation during tensile test was from 2·8 to 15·8 per cent. less than that of similar unmagnetised bars. The actual corresponding differences in elongation percentages were from 0·4 to 5·1 per cent. The average max. load was higher and average breaking load lower for the magnetised than for the unmagnetised bars, but the differences were too slight to be definite. The contraction of the magnetised bars was distinctly less than that of the unmagnetised specimens. No difference in hardness due to magnetisation could be detected by the Brinell method. [See also Abstract No. 969 (1909).] F. R.

1163. *Tension of Electro-deposited Films.* **G. G. Stoney.** (Roy. Soc., Proc. Ser. A. 82. pp. 172–175, May 6, 1909.)—Nickel was electro-deposited from ammonio-sulphate upon one side of steel rules, 102 mm. × 12 mm. × 0·82 mm., causing the rules to bend by as much as 8 to 4 mm. By a simple calculation, if P is the stress in the nickel, $P = \frac{4}{3} Ez(d^2 + td)/tl^2$, or, if the thickness of nickel be small, $P = \frac{4}{3} Ed^2z/tl^2$ approximately. Young's modulus for nickel is assumed to be about the same as for steel. Values of P found range from 19·2 to 7·8 tons per sq. in. Low values, 9·9 and 7·8 tons per sq. in., resulted with a current large enough to give a very rough deposit, and upon depositing at 80° to 90° C. The higher values, 17·2 to 19·2 tons per sq. in., were given upon depositing at 10° to 15°. F. R.

1164. *Strength of Riveted Joints.* **C. Frémont.** (Bull. Soc. d'Encouragement, 111. pp. 658–712, April, 1909.)—The author measures the resistance of a riveted joint to slipping by torsion applied about the axis of the rivet, and the following conclusions are given: The initial temperature of the rivet is without effect upon the slipping resistance of the joint, although for other reasons it is preferable to work at a relatively low temperature, *e.g.*, 900°. The max. temperature reached by the rivet is, however, of great importance, as overheating will diminish the strength of the rivet even though its temperature be allowed to fall before closing. Joints made with rivets of special steels (nickel and chromium, but chemical composition not stated) had practically no resistance to slipping unless the pressure was maintained for a considerable time (60 sec.) in riveting. This has also been noticed by Mesnager (Ann. des Ponts et Chaussés, 8. pp. 114–141, 1906). Such steels, therefore, offer no practical advantage over much cheaper carbon steels. The resistance to slipping is affected by the state of the surfaces of the plates, and although this cannot be adjusted in practice, yet perfect flatness or contact of the parts should be demanded. Contrary to general belief, long rivets give joints with greater adherence than do short ones, provided contact between the plates initially is good. By maintaining the pressure on the rivet during closing, the slipping resistance of the joint can be raised by at least 10 per cent., and sometimes by as much as 60 per cent. A hemispherical head of diam. $\frac{7}{4}$D, where D is the diam. of shank of rivet, is recommended. The edges of the head should be slightly sloped off so as to avoid binding in the die. Detailed results, and photographs, are given. F. R.

1165. *Work of Deformation of Solids.* **J. Weingarten.** (Gesell. Wiss. Göttingen, Nachr., Math.-phys. Klasse, 1. pp. 64–67, 1909.)—Points out that Weyrauch (Zeitschr. f. Architekt. u. Ingenieurwesen, 1908) gives a formula for the internal work done upon a bar in putting it under a load S, from which the third term in the following complete form was omitted—

$$\frac{1}{2}\Sigma\frac{sS^2}{EF}+\Sigma a\tau sS+\frac{8}{2}\Sigma ha^2\tau^2sF,$$

where s, F, E, τ are respectively length, cross-sectional area, modulus of elasticity, and increase of temperature of the bar, $h=8\lambda+2\mu$, λ and μ being Lamé's constants, and a is the coefficient of expansion. F. R.

1166. *Testing Cement in Compression.* **A. Martens.** (Zeitschr. Vereines Deutsch. Ing. 53. pp. 694–698, May 1, 1909.)—Five forms of 50-ton press designed by the author for testing 7-cm. cement cubes in compression are described. A has a hydraulic ram with cup-leather packing; the ram has sufficient range of movement to obviate the necessity of an adjustment of the other platten. B is of the diaphragm (Messdose) type, and requires therefore an adjustment of the opposite head. In C and D this adjustment is at the same end as the diaphragm. E is a form having a plunger with cup-leathers, and F resembles E but has no cup-leathers. Two Bourdon pressure gauges, suitable for use with the presses, are also described, one of which has a loose pointer as maximum indicator, and the other is a recording form. The designs were made at the suggestion of the Verein Deutscher Portland-zementfabrikanten, and working drawings are issued by the Material-prüfungsamt. F. R.

1167. *Reinforced Concrete Beams.* **A. N. Talbot.** (Eng. Record, 59. pp. 663–666, May 22, 1909. From Engineering Experiment Station, Univ. of Illinois, Bull.)—The original gives, with detailed discussion, the results of numerous tests of reinforced concrete beams from 6 to 12 ft. long, of various concrete mixtures, and with various arrangements of reinforcement. In beams without web reinforcement, such as stirrups, failure may occur without warning. Beams with U-shaped stirrups passing under straight reinforcing bars generally gave high web resistance with indication of failure at some period in advance. Beams without stirrups, which had all bars bent up or inclined in the outer thirds of their length carried loads which did not differ much from those with all bars straight, but gave warning of approaching failure. Beams with inclined bars firmly anchored at the ends gave high web resistance and indications of arch action. Good web strength and slow failure were secured by bending up some of the bars and leaving the others straight; much depends upon a proper distribution of the diagonal portions of the bars. These requirements are fulfilled by the Cummings' reinforcement, in which also lateral connection is provided and the main bars are carried to the ends of the beam. Tests of beams with this type of reinforcement showed high strength. As a tentative method for design it is permissible to assume that one-third of the vertical shear is taken by the concrete in the upper part of the beam and two-thirds by the bond with the stirrups, if any. The ordinary working stresses for bond and tension may then be used in the calculation for stirrups if two-thirds of the vertical shear be used as V in the formula $P = Va/d$; and 0·6 of the depth of the beam is used in the calculation for bond. d is the distance from the centre of the reinforcement to the centre of the compressive stresses, a is the spacing of the stirrups, and P is the tension in a stirrup. [See also Abstract No. 878 (1908).] F. R.

1168. *Strength and Elasticity of Old Concrete.* **C. Bach.** (Zeitschr. Vereines Deutsch. Ing. 53. pp. 828–830, May 22, 1909.)—Compression strength and elasticity results already published (Ibid., p. 264, 1907) for concrete up to 2 years old are now extended to 6 and 6¼ years. The compression strength has continued to increase according to the law $a[1-(mA+1)^{-1/6}]$, and the values of the symbols are as follows :—

Concrete.				a.	m.
Cement.	Sand.	Gravel.	Water, Per Cent.		
1	2·5	5	5·7	786	9
1	2·5	5	8·5	897	6
1	2·5	5	8·5	874	6

A is the age in months, and the strength is in kg. per cm.². The compressive strain under a given load is less the greater the age. This applies to both elastic and permanent set. From the results given, the difference in total strain of concrete 100 days, and 6¼ years old is about 20 per cent., for a stress of about 40 kg. per cm.². F. R.

1169. *Measurement of High Pressures.* **A. Martens.** (Zeitschr. Vereines Deutsch. Ing. 53. pp. 747–750, May 8, 1909. Communication from the Königl. Materialprüfungsamt.)—Primary pressure gauges are classified, and two new forms of gauge are described. The first, which has been used at pressures up to 6,110 atmos., is of the differential piston type, with pistons 11·3 and 11·8 mm. diam. respectively, each with a cup-leather packing. By turning the pistons the friction is reduced to a small amount. A small hole is bored in the upper piston so that the contraction of this piston under pressure shall compensate for the lateral contraction of the lower piston under the suspended load. The second gauge is of the differential diaphragm type ["Messdose"; see also Abstract No. 867 (1908)]. The inner diams. of the diaphragms are 20·0 and 20·2 mm. respectively, and the outer 26 mm. in each case. The zero is indicated by the position of a thread of mercury in a capillary with a magnification of movement of 1,000 : 1. The range is up to 60 atmos. The loading in both instruments is similarly performed. The series of dead weights are picked up progressively by the suspending rod by turning a pointer to marks. There are three pointers in either instrument; in the first, the pointers pick up weights corresponding respectively to 1,000's, 100's, 10's of atmospheres, and in the second 10's, 1·0's, and 0·1's of an atmosphere. F. R.

1170. *Inertia and Mass.* **V. Dwelshauvers-Dery.** (Engineering, 87. pp. 803–804, June 11, 1909.)—The author contends that modern physics has not proved "mass" to vary with the speed; that there is an underlying fallacy in the argument, the treatment of inertia as if it were a force, a resistance; then it is found that considered as a force, as a resistance, inertia proper is null, which is correct; but it does not follow that the material mass of bodies is null. Abraham and Kaufmann have shown, not that mass is variable, but that the resistance of kathodic corpuscles of electromagnetic origin varies with their velocity. A. D.

1171. *Vector Notation.* **C. Burali-Forti** and **R. Marcolongo.** (Elettricista, Rome, 8. pp. 119–120, April 15, 1909.)—A table showing a proposed notation for vector analysis is given, and the advantages of the system over the systems at present in use. For example, the vector from A to B is written B − A, instead of AB, $\overline{\mathrm{AB}}$, or (A B). Similarly a scalar product is written $a \times b$, and a vectorial product $a \wedge b$. S. G. S.

1172. *Glass-cutting by means of an Electric Wire.* **F. L. Jouard.** (Amer. Chem. Soc., Journ. 31. p. 654, June, 1909.)—To cut across a glass bottle or other vessel, a scratch about ¼ in. long is made either on the emery wheel or by means of a file, and a thin resistance wire, passing through the scratch, is wound tightly round the vessel in a single loop, between the crossed ends of which a small piece of asbestos paper is placed. This wire is connected by means of two pieces of insulated copper wire with the mains (110 volts), a suitable rheostat being inserted in the circuit so that the current is just sufficient to heat the resistance wire to dull redness. In this way the crack formed follows exactly the course of the wire. T. H. P.

1173. *Discharge of Water from Circular Weirs and Orifices.* **G. H. Gulliver.** (Roy. Soc. Edinburgh, Proc. 29. pp. 295–308, 1908–1909.)—The total discharge of water from a circular orifice of diam. D, in which the level of the water is at a height H from the lowest point of the orifice, is—

$$2\sqrt{2g}\int_0^{\mathrm{H}} \sqrt{h(\mathrm{H}-h)\left[\mathrm{D}-(\mathrm{H}-h)\right]}\,.\,dh \text{ cub. ft. per sec.},$$

an integral which is elliptic, and does not admit of direct mathematical solution. Results have been obtained by graphical means, the curve of actual discharge being similar to that found for the theoretical discharge. Both curves are sensibly straight lines for positions of the water surface between the centre and top of the orifice. The coefficient of discharge is probably between 0·625 and 0·630 for low heads. [Compare Abstract No. 708 (1908).] W. H. St.

1174. *Motion of a Metal Wire through a Piece of Ice.* **J. H. Meerburg.** (Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 886–890, May 24, 1909.)—Quincke ascribes the turbidity formed in ice by a metal wire sinking through it [Abstract No. 2154 (1905)] to occluded salt solution with a refractive power different from that of the ice containing it. The author has repeated some of his experiments [see Abstract No. 1286 (1907)], using boiled and frozen distilled water, both pure and containing a little sodium sulphate, and a wire from the same piece as that previously employed. In this case, too, the value of C is only about 40 per cent. of the theoretical number, and is the same for the water containing sodium sulphate as for pure water. Observation of the liquid above the wire shows that Quincke's "solidified foam-bubbles of oily salt-solution" are in reality liquid. Immediately above the wire and at the sides above the lower half of the wire, that is, where the water is released from pressure, there appear innumerable small bubbles, which often grow and shrink rapidly and which are found to be vacuous. Since much liquid is found above the wire, where also there are empty spaces, a flow of water would be expected to take place in the ice from the sides towards the interior: such inward flow was actually observed. The heat necessary for the melting under the wire is consequently only partly furnished by the solidification above it, the remainder of the requisite heat being probably furnished partly by means of radiation. T. H. P.

1175. *A Graphic Solution of Kutter's Formula.* **L. I. Hewes** and **J. W. Roe.** (Amer. Inst. Mining Engin., Bull. 29. pp. 453–454, May, 1909.)—A description of a chart from which we may read off the mean velocity of a canal or stream. It consists essentially of three parallel scales—one for the mean velocity V, one for the hydraulic radius R, and one for the slope; a diagonal (not graduated); and a set of curves for the various values of *n*, the factor which involves the nature and condition of the bottom of the canal. The ranges of values on the V scale vary from 0 to 25 ft./sec.; R varies from 0 to 50 ft.; the slopes vary from 16 to 1 in 2 miles, and the *n*-curves cover all the values given in any of the books of reference. W. C. S. P.

1176. *Surface Tension of Water by Jet Vibration.* **N. Bohr.** (Roy. Soc., Phil. Trans. Ser. A. 209. pp. 281–317, May 25, 1909.)—In adopting Rayleigh's method of jet vibration for the determination of surface tension of water, the author uses glass tubes of elliptic section quite free from twist, believing these orifices to be preferable to apertures in thin plates. Also in the development of the theory for the present case, elaborate analysis is used to allow for the effect of viscosity and finite wave amplitude. The results obtained vary between 72·98 and 73·45, the mean final result being 73·23 dyne/cm. for tap-water at 12° C. P. O. Pedersen's result by the same method was 74·46 [see Abstract No. 885 (1908)]. E. H. B.

1177. *Molecular Vibrations.* **E. Madelung.** (Gesell. Wiss. Göttingen, Nachr., Math.-phys. Klasse, 1. pp. 100–106, 1909.)—In a bar of elastic material, longitudinal and transverse stationary vibrations may occur in a known manner. The wave-lengths of these vibrations have a superior limit fixed by the length of the bar. An inferior limit is given by the distance between the molecules of the substance. The calculation of the frequencies in this inferior limit is here carried out for rock salt, sylvin, and fluorspar (NaCl, KCl, and CaF_2), both longitudinal and transverse vibrations being dealt with. The conclusion is made that the natural vibrations postulated in the electromagnetic theory of dispersion in the region of the infra-red are stationary elastic longitudinal vibrations. E. H. B.

1178. *Kinetic Criterion of Potential Energy.* **C. V. Burton.** (Phil. Mag. 17. pp. 692–706, May, 1909.)—Often, if not always, energy which is conveniently treated as potential, is found on closer scrutiny to be kinetic, and the author's object here is to obtain a criterion of the justifiability of treating kinetic energy of conservative dynamical systems as potential. If $\phi_1, \phi_2, \ldots$ are the co-ordinates defining the configuration, the potential energy is a function of the ϕ's only, while the kinetic energy is a function of the ϕ's and $\dot{\phi}$'s. If the former is essentially kinetic, it follows that additional "ignored" co-ordinates ψ must be involved in the so-called potential energy. Call this K, and the kinetic energy proper T, and let C_1 be the momentum corresponding to ψ_1, and Φ_1 the impressed force corresponding to ϕ_1. It is then shown that the equations of motion may be expressed in the Kelvin and Tait form—

$$\Phi_1 = \frac{d}{dt}\frac{\partial T}{\partial \dot{\phi}_1} - \frac{\partial T}{\partial \phi_1} + \frac{\partial K}{\partial \phi_1} + C_1\left\{\left(\frac{\partial M_{11}}{\partial \phi_2} - \frac{\partial M_{12}}{\partial \phi_1}\right)\dot{\phi}_2 + \left(\frac{\partial M_{11}}{\partial \phi_3} - \frac{\partial M_{13}}{\partial \phi_1}\right)\dot{\phi}_3 + \ldots\right\}$$

$$+ C_2\left\{\left(\frac{\partial M_{21}}{\partial \phi_2} - \frac{\partial M_{22}}{\partial \phi_1}\right)\dot{\phi}_2 + \left(\frac{\partial M_{21}}{\partial \phi_3} - \frac{\partial M_{23}}{\partial \phi_1}\right)\dot{\phi}_3 + \ldots\right\} + \&c.,$$

where the M's are defined by equations of the type—

$$\dot{\psi}_i = \partial K / \partial C_i - (M_{i1}\dot{\phi}_1 + M_{i2}\dot{\phi}_2 + M_{i3}\dot{\phi}_3 + \ldots),$$

provided the system is acted on by no external forces other than those of type Φ. The required additional conditions are therefore determined by the series of equations of the type—

$$\Sigma C_i (\partial M_{ij} / \partial \phi_k - \partial M_{ik} / \partial \phi_j) = 0.$$

In the case of a system specified by a single co-ordinate ϕ_1 and acted on by no external forces except Φ, these conditions will necessarily be satisfied, so that the energy K due to the *ignored* momenta will necessarily behave as potential energy. This will also be the case for a system in which for a given set of values of the ϕ's, the $\dot{\psi}$'s are independent of the $\dot{\phi}$'s, and determined solely by the momenta. It will, moreover, hold for any system whose state, as defined by the ϕ's, is one of continued rest, provided that it is not acted on by external forces other than those of type Φ, since the $\dot{\phi}$'s are then constantly zero. The energy due to the *ignored* co-ordinates may therefore always be treated as potential energy in computing what forces, corresponding to the working co-ordinates, must be applied to produce equilibrium in the absence of any other external forces. As an example of the application of the method, it is shown that: If in a frictionless liquid free from vortex motion a number of solids are immersed, each consisting of a rigid framework of thin wires, then the energy of the circulation-momenta may be treated as potential energy, provided that for each single solid the impulses required to initiate all the circulations of that solid are such as, being applied to a rigid body, would be in equilibrium. The method is further applied to establish the validity of treating the translational energy of gas molecules under adiabatic conditions as potential energy on the basis of the usual assumptions. G. W. DE T.

1179. *The Semi-diurnal Variation of Pressure in Arctic Regions.* E. Alt. (Meteorolog. Zeitschr. 26. pp. 145–164, April, 1909.)—The semi-diurnal variation of the barometer in tropical and temperate latitudes may be expressed by the expression, $a_2 \sin (155° + 2x)$, the phase being practically constant for the whole globe if the hour angle x be reckoned in local mean time. The author has analysed harmonically the hourly or two-hourly observations available for 14 stations north of lat. 70°, and finds that this constancy of phase is not maintained in these high latitudes if the observations are referred to local time, but if G.M.T. be adopted the phase angles are closely alike at all stations. The semi-diurnal variation may be expressed by $c \sin (110^\circ + 2x)$ if x be expressed in G.M.T., or by $c \sin (110^\circ + 2\lambda + 2x)$, where λ represents the longitude West of Greenwich if x be expressed in L.M.T. The greatest difference of the phase angle from 110° is only 21°·6, corresponding with a difference in the time of maximum in 42 minutes. Margules has shown that a vibration of the atmosphere with nodes at the poles and at the equator, would have a free period of 0·5165 day. The above results point to the existence of such a vibration of appreciable amplitude in high latitudes. The semi-diurnal variation as observed is thus due to the interference of two vibrations, and may be represented by the addition of the two harmonic terms $b \sin (155^\circ + 2x) + c \sin (110^\circ + 2\lambda + 2x)$, (all times being referred to local mean time). The following values (in mm.) have been obtained for the amplitudes b and c: For 13 stations between 70° and 81° N. $b = 0{\cdot}024$, $c = 0{\cdot}084$; for 11 stations between 60° and 70° N. $b = 0{\cdot}048$, $c = 0{\cdot}080$; for 16 stations between 50° and 60° N. $b = 0{\cdot}178$, $c = 0{\cdot}046$; for 8 stations between 45° and 50° N. $b = 0{\cdot}324$, $c = 0{\cdot}025$. South of lat. 45° the polar oscillation could not be identified; it is entirely masked by the now very much greater oscillation along parallels of latitude. The phase of the polar oscillation is probably determined by the distribution of land and water in the Northern Hemisphere. The time of maximum, 11h. 20′ G.M.T., corresponds approximately with the time of minimum pressure on the great land masses of Siberia and America. R. G. K. L.

1180. *Great Inversion of Temperature.* **A. J. Henry.** (Monthly Weather Rev., Washington, 37. p. 22, Jan., 1909.)—A remarkable case of inversion was observed on Mount Weather on Jan. 9, 1909. Temperature at ground (526 m.) − 7·2° C.; at 1,750 m. + 9·0° C.: difference, 16·2° C. At Oklahoma and in the lower Lake region a rise of temperature of 20° F. occurred on the same day. At Mount Weather a rise of temperature at the surface took place on the following day. R. G. K. L.

1181. *Variability of Barometric Means.* **A. Angot.** (Comptes Rendus, 148. pp. 1131–1133, April 26, 1909.)—The term "normal" is used conventionally to designate mean values for long periods, but these normals only have real significance if the variations shown from year to year bear a definite relation to those due to accidental causes. According to the theory of errors, out of 1,000 observations 736 should show a divergence equal to or greater than half the probable error e, and 500, 177, 43, and 7 should show respectively divergences equal to or greater than e, $2e$, $3e$, $4e$. A discussion of pressure observations for France and neighbouring countries for the 50 years 1851–1900 has given the values 744, 515, 185, 38, and 2. The use of these pressure normals is therefore legitimate. The value of e increases regularly from south to north. For the whole year and for Jan. respectively it is 0·07 and 0·39 mm. for Perpignan and 0·10 and 0·52 mm. for Greenwich. For the normal pressure-difference between two places the values of e are much smaller. For Paris–Greenwich they are 0·04 mm. for the whole year, and 0·14 mm. for Jan. If ν be the mean of the differences between successive values of the series, and m the mean divergence from average, taken irrespective of sign, theory shows that the ratio ν/m has a limiting value $\sqrt{2} = 1{\cdot}41$, if the successive values are entirely independent of one another. If, on the other hand, successive values are not independent, as is the case with periodic phenomena, the ratio v/m is less. For the number of sun-spots for the period 1851–1900, $v/m = 0{\cdot}62$. For pressure observations the following values have been obtained: Greenwich, 1·48; Paris, 1·38; Nantes, 1·42; Geneva, 1·47; Perpignan, 1·47. We conclude that it is useless to examine pressure data for periodicities of duration between two or three years and forty years. If such periodicities exist their amplitude must be negligible in comparison with that of the accidental variations. R. G. K. L.

1182. *Compensation between the Character of the Seasons in different parts of the World.* **H. H. Hildebrandsson.** (Comptes Rendus, 148. pp. 1559–1562, June 7, 1909.)—Several attempts have been made to discover evidence of the interdependence of the seasons in different parts of the world. Guided by the supposition that the temperature of the polar seas has an important influence in the world's weather the author brings forward evidence for the following: (1) The summer temperature near the North Cape is "opposed" to that of the following spring in Iceland. (2) The polar current which reaches Iceland in March only enters Baffin Bay in the following winter, and thus the air temperature at Gothaab (west coast, Greenland) in spring has a similar divergence from normal to that at Grimsey (North Iceland) in March of the preceding year. (3) The cold water leaving Baffin Bay in winter reaches the banks of Newfoundland in the following summer. The winter air-temperature at Upernivik (Baffin Bay) is inverse to that of the following July at St. John's. The temperature at St. John's in July is highest in those years which have the greatest amount of ice in the Atlantic. As explanation of this apparently contradictory result, it is suggested that the low water-temperature gives rise to anticyclonic conditions, and this pressure distribution favours the development of high temperatures over the land in summer. (4) The branch of the polar current which at the end of winter passes to the north-east of Iceland continues its course towards the south-east to Thorshavn (Faroe) and into the North Sea, and brings with it a more or less low temperature and consequently high pressure. This is the cause of the high pressure which generally prevails over this region in spring. This distribution brings cold northerly winds to Europe, which extend even into Hungary. The divergence of the pressure in spring at Thorshavn is always opposed to the divergence of the simultaneous temperature at Debreczin in Hungary. The Siberian temperature is also found to be the inverse of that over Europe. (5) In autumn a similar opposition prevails between the divergence of the temperature at Thorshavn and Barnaul (Siberia). (6) During winter (Oct.–March) the curves for precipitation for Thorshavn and Barnaul are opposed to one another, but the variations at Thorshavn and Zi-ka-wei (Shanghai) are almost identical. (7) In winter there is also opposition between the precipitation over the Iceland sea and over Central Europe, Southern France, and even over the Azores. (8) The curve of winter rain for Java is almost identical with that for pressure during the following summer at Bombay. R. G. K. L.

1183. *Amplitude of Atmospheric Temperature and Distribution of Land and Water.* **M. Tsutsui.** (Meteorolog. Zeitschr. 26. pp. 235–236, May, 1909. From the Japanese Meteorolog. Journ. of Science, Oct., 1908.)—The author examines the records of 14 meteorological stations situated on the coast of Central Houshu with the object of ascertaining, whether the amplitude of the temperature variations is influenced by the distribution of land and water about the stations. He finds a formula, considering a circular area of 8 km. radius about that station as a centre. In a note added to the original paper **Ishida** points out that the formula ought to contain the latitude of the stations; his own formula, based upon researches made at 40 stations situated between lat. 22 and 45° N., is in better agreement with the observations than Tsutsui's formula. H. B.

1184. *Variation in the Amount of Cloud over Scandinavia.* **A. S. Steen.** (Meteorolog. Zeitschr. 26. pp. 201–209, May, 1909.)—The author confines his attention to observations of cloud amount made during the daylight hours [see Abstract No. 774 (1909)]. For stations observing at 7, 14, 21 h. he can thus use only the observations made at 14 h. (2 p.m.). He has computed the monthly averages for the 30 years 1874–1903, for 24 Norwegian, 17 Swedish, and 8 Danish stations. Taking the mean of all stations the results show a maximum in December and a minimum in May or June. The stations are subdivided into 6 groups. All show the winter maximum and summer minimum, but in addition there are a number of secondary points of inflection in the curves. The most important is a minimum in September. On comparing the results with those for other elements we find a similar secondary September minimum in the rainfall at Danish stations. In the later part of the paper the variation from year to year in the mean annual cloudiness for all 49 stations is compared with the variation in the solar protuberances. The two curves show a suggestive agreement. R. G. K. L.

1185. *Amount of Moisture in Fogs.* **A. Wagner.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 1281–1298, Dec., 1908.)—Observations were made on the Sonnblick in July, 1908, on the percentage humidity of fogs and on the amount of moisture contained in each m.^{3}. I. For the former measurement four hair hygrometers of different patterns were used. The instruments were standardised by placing them (1) in a cellar in which a constant humidity of 95 per cent. was maintained; (2) in a steam chamber in which the air was saturated. The humidity in the cellar was determined with an Alluard dew-point hygrometer. The humidity, as measured by these hygrometers, exceeded 100 per cent. on all occasions of fog except those on which the sun's disc could be seen. If we omit these cases of light fog, the mean humidity during fog was 102·4 per cent. The seven cases omitted give a mean of 90·5 per cent. The question whether this supersaturation is real is then discussed, but no very definite result is arrived at. It is not caused by water-drops adhering to the apparatus and influencing the readings mechanically. The vapour pressure is greater over curved surfaces than over flat ones, but the amount of supersaturation is too great to be explained from the curvature of the drops. II. The amount of water per m.^{3} was determined by drawing air into a wide-necked bottle of 18·56 litres capacity and then passing it through H_2SO_4 and $CaCl_2$ and determining the moisture chemically. From the known temperature and pressure the amount of water-vapour present can be calculated, and subtraction gives the amount of liquid water per m.^{3}. The amount varied between 0·12 gm. and 4·84 gm., the mean of 22 experiments gave 2 gm. The weight of water present in the liquid state was always smaller than that present as vapour. The distance at which objects could be seen was very nearly proportional inversely to the amount of liquid water present per m.^{3}. No definite relation was found between the visibility and the size of the drops as determined by optical methods.

R. G. K. L.

1186. *Temperature Observations in Loch Garry.* **E. M. Wedderburn.** (Roy. Soc. Edinburgh, Proc. 29. pp. 98–185, 1908–1909.)—Assisted by W. Macdonald the author made observations during the first seven months of 1908 in Loch Garry (Inverness-shire). The main basin has a length of 4 miles and a minimum depth of 220 ft.; almost separated from it by a narrow, very shallow channel is the small basin, 1 mile in length, 40 ft. in depth. As the recording instruments used in Loch Ness did not answer (the cable insulations failed), reversing mercury thermometers were applied, for which Macdonald devised a simple messenger, a metal bar twisted into a spiral and screwed on to the sounding line. The water entering the loch in the course of a year has about 5 times the capacity of the basin, and more heat comparatively is lost through the outflow of the warm surface water than in the case of Loch Ness, where the outflow is small; the drainage area of Loch Garry is likewise relatively large. On the whole the temperature of the water at different depths is very uniform in the winter months owing to the mixing of the waters by the wind; but on clear, calm nights irregular, isolated patches of ice may form in the middle of the lake, not connected with the ice on the shallow shore; these patches disappear when the wind mixes the cold surface water and the water below. When the surface begins to cool, discontinuity layers are formed, and the return current is not directly appreciable afterwards at the bottom of the lake. In general strong winds produce currents at considerable depths; these were measured by an Ekman propeller current-meter which sometimes marked the bottom current to be directly opposed to the surface current. Temperature seiches are observed and may thus occur in small temperate lakes even when discontinuity is not pronounced. H. B.

1187. *Temperature of the Wolfgangsee.* **F. M. Exner.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 1295–1315, Dec., 1908.)—The observations [see Abstract No. 1569 (1908)] have been renewed by the author and K. R. v. Frisch, July to Sept., 1908, with the aid of Richard thermographs, which were placed in copper kettles attached to anchored wire ropes. The thermographs were thus surrounded by air, and responded sluggishly to small temperature-differences, and as the kettles were not watertight, the thermographs sometimes got out of order, which was not discovered till the end of the week, when the card was renewed. Direct temperature measurements were taken every 3 or 4 days. The position of the Sprungschicht (discontinuity layer) was determined with the aid of empty bottles, which were opened and filled at various depths, and was found to lie between 8 and 12 m. The 8-m. temperature curve kept fairly constant, but showed irregular peaks pointing downwards (temperature diminutions) lasting for several hours; the 12-m. temperature curve marked periodical fluctuations in addition to the irregular upward peaks. Thus it looked as if the changes were due to the rising and sinking of the mean layer at 10 m. depth. Those changes were noticeable particularly with south winds which produced waves at the northern end of the lake where the observations were taken. The discontinuity layer would, in the sense of Watson and Wedderburn, separate strata of different densities, and would be tilted more or less from its horizontal position by the wind. At 12 m. depth periodical temperature fluctuations of periods of 24, 8, and 16 hours could be observed in calm weather. The direct temperature observations indicate that the heat is stored in the lake water; the air temperature and the $d\vartheta/dt$ ($\vartheta =$ water temperature, $t =$ time) are parallel. The solar radiation was not determined. H. B.

1188. *Intermittent Phenomena in the Gouffre de Poudak (France).* **E. A. Martel.** (Comptes Rendus, 148. pp. 1426–1427, May 24, 1909.)—The gorge is situated near Plan-de-Ponts, Dept. Hautes Pyrénées, at an altitude of 540 m., and consists of a roughly rectangular pit, 80 by 10 m. Water was found about 20 m. below the surface and had a max. depth of 14·5 m. ; two subterranean canals at the ends of the pit could not be examined. The water rose by about 4 m. in 15 min. and sank slowly again, the period being 58 min. About 150 m. N.E. of the gouffre there is another hole, in which the water-level changes had a period of just half the 58 min.—29 min. The phenomena are little known and not of frequent occurrence, and were observed after a heavy rainfall in Aug., 1908. Fluorescein thrown into the Poudak pit reached the other pit in 45 min. H. B.

1189. *Italian Earthquake of December* 28, 1908. (Nature, 80. p. 445, June 10, 1909. From the Bolletino Bimensuale of the Italian Meteorolog. Soc. and the Rivista Geografica Italiana.)—According to **G. Martinelli**, the earthquake was felt in Southern Italy, Sicily, Montenegro, on the Albanian coast, and on the Ionian Islands of Cephalonia, Zante, and Corfu. The greatest violence was in the neighbourhood of the Straits of Messina, but there were two independent centres in Sicily near Raddusa and near Augusta, in which the violence also reached 7 or 8° on the Mercalli scale. The disturbance of the sea was felt on part of the north coast of Sicily, otherwise only south of the Straits. According to **G. Platania** the sea receded first in all the instances; then followed a great wave, which at Messina had a height of 2·70 m., and at Giardino and Ali rose to 8·50 m. The tidal gauges marked sea-waves at Naples, Ravenna, and Malta. The Gazzi-Gallico cable was broken and lost; the cable to the Lipari Islands and several others were uninjured. H. B.

1190. *Upper Layers of Solar Atmosphere.* **H. Deslandres** and **L. d'Azambuja.** (Comptes Rendus, 148. pp. 1011–1015, April 19, 1909.)—With the special form of spectroheliograph described in previous notes [Abstracts Nos. 1585, 1761 (1908), 81 (1909)] the authors have succeeded in isolating the fine centre core line K_3 of the calcium Fraunhofer line, and then photographing the structure of the upper layer of the solar atmosphere. These images are distinguished by the presence of well-marked extended masses called *filaments.* C. P. B.

1191. *Spectroheliograms of Solar Atmosphere.* **G. E. Hale.** (Comptes Rendus, 148. pp. 1025–1026, April 19, 1909.)—Referring to Deslandres' note [see preceding Abstract] on the isolation of the central positions of various dark Fraunhofer lines for spectroheliographic registration, the author states that most of the H photographs at Mount Wilson have been obtained with a two-prism instrument having a focal length of about 1·5 m., but some have been taken with a much more powerful instrument of 9 m. (30 ft.) focal length. It is found that the relative intensity of bright or dark flocculi is determined by the position of the secondary slit with respect to H_α. If only the central part of the ray is allowed to fall on the plate, the bright flocculi are very intense; if the light is from the edge of the line the dark flocculi are strongest, while the bright masses are feeble or invisible. Comparison photographs have been taken with light from either side of the H_α line. If anomalous dispersion is in force, these should show notable differences, especially in the regions near the sun's limit and in the neighbourhood of spots. No such differences are evident, and this indicates that anomalous dispersion is not a factor in these solar phenomena. Certain small differences are found, which may be due to various causes. C. P. B.

1192. *Original Canals of Martian Doubles.* **P. Lowell.** (Lowell Observatory Bulletin, No. 37. Nature, 80. p. 260, April 29, 1909. Abstract.)—Occasionally one of the component lines of a double canal on Mars becomes more conspicuous than the other, and continued observations indicate that it is always the same component which is so affected. A table is given showing eighteen of these peculiar canals, out of a total of twenty-two observed during 1907. C. P. B.

1193. *The Relation between Period and Density of Algol-Variables.* **J. Stein.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 449–458, March, 1909.)—A maximum value of the mean density of an Algol system can be derived from the period P, and the total duration of eclipse $2t_0$. If the orbit is supposed to be circular, this max. value D is given by $K/D = P^2 \sin^3 nt_0$; $nP = 2\pi$, where K is constant, and P and t_0 may be expressed in hours, D in the mean density of the sun as unity. This value is identical with the real mean density δ if the inclination of the line of sight to the orbit is zero and the two stars are the same size. D is not very different from δ if the two stars do not differ much in size. The value found for K is 81·17. A list is given of 88 Algol stars, together with their values of P, $2t_0$, D, $R = 1/D$, and for 10 of the stars the mean densities δ derived by Ristenpart from Graff's elements. The small differences $D - \delta$ show that D is a fairly approximate value of δ. A rough preliminary calculation showed that there can be no question of proportionality between P^2 and R (the "rarity"). But the product PD oscillated between relatively narrow limits. Hence an investigation of the correlation between P and R was undertaken. The value found for the correlation is $0·788 \pm 0·051$, or excluding 4 stars of period over 6 days, $0·781 \pm 0·054$. The corresponding probable value of R is $0·215\,P - 68 \pm 7·46$, or, in the second case, $0·217\,P - 51 \pm 4·66$. "Thus the magnitude of correlation seems to indicate a real relationship between period and density, or, more exactly, between period and duration of eclipse." For stars of a period somewhat greater than 8 days it is found that $P \sin^3 nt_0 = 6·78$ approximately, and if P is very large $(2t_0)^3 = 216P^2$. A note contains a remark by Pearson emphasising the point that the relation found between P and D is, properly speaking, a relation between the period and the observed duration of eclipse. Thinking that these must be very closely related, he has worked them out, and found for the correlation between P and t_0 the value $+0·877$. The correlation of D and P is a secondary result of this. The author, following up Pearson's suggestion, tabulates for seven values of P, from 25 to 250 hours, the corresponding values of $2t_0$ derived from formulæ obtained by both methods. A. E.

1194. *Correlation and the Characters of Variable Stars: in reply to Pearson.* **H. C. Plummer.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 348–354, March, 1909.)—It is suggested that Pearson [see Abstract No. 428 (1909)], possibly misled by a certain want of familiarity with the subject of variable stars, has made a not altogether judicious use of his own machinery. For instance, in the case of long-period variables, Pearson finds a correlation between the light-range and max. light of 79 stars which is little short of unity. If this means anything, it should mean that the light-range is almost rigorously a linear function of the max. light. But if this be so, a similar relation ought to hold between the max. light and the minimum light, which is not the case. Hence it is impossible to draw any useful conclusion from the figure found for the correlation, the magnitude of which is accounted for by the fact that the minimum light is very small in comparison with the maximum. An apparent theoretical oversight made by Pearson is also pointed out, which might lead to the obtaining of a large spurious coefficient of correlation. The point of interest of the discussion of the Algol stars, in view of its bearing on the eclipse theory, is that apparently the period is *positively* correlated with light-fluctuation. The increase of light-fluctuation with period, *ceteris paribus*, seems altogether surprising if it be real. Pearson suggested, to meet the difficulty, that a large orbit implies a large eclipsing body. An alternative process of physical development is suggested in the present paper. With lapse of time, as tidal action increases the period and distance between the two component stars of a binary system, a difference of luminosity may develop between the two; and the effect of increasing contrast may suffice to counterbalance the effect of increasing distance on the light-fluctuation. The facts by which such conjectures are prompted are, however, much obscured by the uncertainties to which random and natural selection may give rise. Moreover, the eclipse theory has been assumed in their interpretation. To conclude, the belief is expressed that more will be done by the careful study of a few typical variable stars than by accumulation of unco-ordinated material and the indiscriminate "volley-firing" of a statistical method. A. E.

1195. *Photographic Determination of Star Colours.* **O. Bergstrand.** (Comptes Rendus, 148. pp. 1079–1081, April 26, 1909.)—A method, due to the brothers Henry, was adopted of determining photographically the mean wave-length of the light of each star. The method has the advantage of enabling the coefficient of refraction specially applicable to the star observed to be directly deduced. The plates (Lumière, violet label) were exposed in the large Meudon reflector (1 m. aperture). Before the mouth of the telescope was placed a reticule, with parallel bands and spaces each 1·5 mm. wide. This reticule produces at the focus a series of diffraction spectra symmetrically placed on either side of the principal image. By measuring the distance between the two first-order spectra, the effective wave-length for the star in question can be determined. The investigation comprises 92 stars in Müller and Kempf's photometric catalogue. The colours in the catalogue are designated by the numbers from 0 to 18. In this scale white = 0, yellowish-white = 3, whitish-yellow = 6, yellow = 9, red = 18. As might be foreseen, the influence of duration of exposure on the effective wave-length λ was much less pronounced in the reflector than in refractors. Let Δλ denote the change in λ for a prolongation of exposure corresponding to one step in magnitude. On determining Δλ for different colour-types and magnitudes (as measured by the breadth D of the spectrum) it was found that Δλ follows a different law for white stars (colours 0 to 4) and yellow stars (colours 5 to 12). In this respect the transition from the yellow-white to the white-yellow stars is abrupt.

		D < 0·10.	0·10 to 0·14.	0·14 to 0·18.	> 0·18 mm.
White stars	Δλ =	+ 0·7	+ 2·5	+ 2·8	+ 1·1 μμ.
Yellow "	Δλ =	− 0·7	− 0·4	− 0·1	+ 1·9 μμ.

The same peculiarity was found when Osthoff's colour scale was tried instead of Müller and Kempf's. The values of λ for colours 0 to 12 are tabulated and also exhibited in a curve. The curve from 0 to 3½ is nearly horizontal, rising very gradually from 0 to 3. At 3½ it bends sharply upward. After 5 or 6 the ascent is less rapid. The values of λ seem to follow fairly well the scale of Harvard spectrum classes: B, A, F, G, K, M ($\lambda = 415\,\mu\mu$ for class B, $\lambda = 450\,\mu\mu$ for class M). The general result of the work is that the stars fall into two great classes: the white stars ($\lambda = 420\,\mu\mu$, spectra B and A) and the yellow stars ($\lambda = 440$ to $450\,\mu\mu$, spectra K and M). The qualities of the two classes seem to be considerably different and the transition from one to the other rather abrupt. The effective wave-length $430\,\mu\mu$ (nearly that of our sun) marks the limit between the two classes. It is noteworthy that just the colours 4 and 5 and the spectra F and G, which represent the intermediary state, are relatively rare. A. E.

1196. *Red Stars in Sagittarius.* **Mrs. Fleming.** (Harvard College Observatory, Circular No. 149. Nature, 80. p. 288, May 6, 1909. Abstract.)—From the examination of the Draper Memorial plates of stellar spectra an abnormal number of red stars were detected in the region about Sagittarius; these showed peculiarities in their spectra, some of them containing bright lines. C. P. B.

REFERENCES.

1197. *New Chronograph.* **G. Abetti.** (Mitt. d. Grossh. Sternwarte zu Heidelberg (Astronomisches Institut), No. 12, 1908. Zeitschr. Instrumentenk. 29. p. 119, April, 1909.)—Short description, with drawing, of magnetic puncture needle apparatus for eliminating several of the errors inherent in the usual form of chronograph marker. C. P. B.

1198. *Cutting Resistance of Metals.* **H. Friedrich.** (Zeitschr. Vereines Deutsch. Ing. 53. pp. 860–866, May 29, 1909.)—Discusses the results of Taylor [see Abstract No. 369 (1907) and of Nicholson upon cutting, and of Schlesinger upon grinding, with special reference to the formulæ proposed to express them. F. R.

1199. *Question in Mechanics.* **A. N. Dinnik.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 41. No. 2, pp. 81–85, 1909.)—The author shows that it is possible to dispense with the discontinuous functions usually introduced in studying the theory of impact if the elastic deformations of the impinging bodies are taken into consideration. All the magnitudes characterising the mechanism of impact are then represented by functions continuous with time. T. H. P.

1200. *Discontinuous Phenomena.* **N. Campbell.** (Cambridge Phil. Soc., Proc. 15. pp. 117–136, May 21, 1909.)—The application by Kohlrausch, by Meyer and Regener, and by Geiger of v. Schweidler's theory of the discontinuities in the emission of rays by a radio-active substance to the measurement of the charge carried by an α-particle opens up a new and most important field of physical research. The theory of v. Schweidler's method is here discussed in the hope that it may then rival in accuracy the more direct method used by Rutherford and Geiger. [See also Abstracts Nos. 626 and 926 (1908).] E. H. B.

1201. *Extensions of Fourier's and the Bessel–Fourier Theorems.* **W. M'F. Orr.** (Roy. Irish Acad., Proc. Sect. A. 27. pp. 205–248, June, 1909.)—The investigations in the first part of the paper are connected with vibratory motion in the space outside a sphere or an infinitely long cylinder. Very general solutions of the differential equations of the motion are obtained. In the second part the expansion of an arbitrary function of x in terms of sines and cosines or of conjugate Bessel functions is discussed. The series are of great generality and have been rigorously established. A. R.

LIGHT.

1202. *Two New Apparatus for the Production of Emission Spectra.* **R. Krulla.** (Zeitschr. Phys. Chem. 66. 1. pp. 78–80, March 23, 1909. Laborat. f. anorgan. Chemie an d. k.k. techn. Hochschule, Wien.)—Two new apparatus for obtaining the spark spectrum of solutions. The first consists of a double **U**-tube, one of the limbs of which is much longer than the other. This tube is fitted up vertically, and a solution of the required salt is run in until it overflows down the shorter limb. A dropping-funnel, with a fine orifice, also filled with the same solution, is suspended with the delivery tube inside the long limb of the **U**-tube so that the orifice is a few mm. above the level of the liquid. Platinum wires are sealed into the funnel and **U**-tube to connect two liquids with an induction coil, so that when the stopcock of the funnel is opened to allow the liquid to drop out, sparks pass between the two liquid surfaces. No air lines are obtained in this way, the metallic spectra being very pure. The second apparatus consists of two funnels having very fine orifices, and their delivery tubes bent to an angle of 105°. The funnels are fixed vertically and so oriented that the fine jets of salt solution pass within 2 mm. of each other. On connecting the liquid in each funnel to the pole of a secondary coil a rain of sparks pass between the two liquid streams. The results obtained with these pieces of apparatus are very satisfactory if care be taken to regulate the discharge to the size of the drops in the one case and the streams in the other. E. C. C. B.

1203. *Use of Rock Salt in Optical Instruments for the Ultra-violet.* **A. Pflüger.** (Phys. Zeitschr. 10. pp. 405–406, June 15, 1909. Physikal. Inst. d. Univ., Bonn, April, 1909.)—Rock salt possesses very great transparency for the ultra-violet rays, and, moreover, shows a great superiority over both fluorite and quartz in having a far greater dispersion. The actual values of the dispersion of the three materials, using a 60° prism in each case, are as follows :—

λ.	Fluorite.	Quartz.	Rock Salt.
1850–2310	3° 5′	5° 40′	27° 10′
2310–3400	2° 20′	4° 20′	10° 10′
3400–3940	26′	40′	2° 20′

The deterioration of the surface of the rock-salt prism may be guarded against by cementing a thin plane-parallel plate of quartz by means of glycerine. This, however, absorbs all rays of shorter wave-length than $\lambda = 2300$. It is also possible to construct achromatic lenses of rock salt and quartz, a triple combination being used, the rock salt being in the centre. A very effective spectrograph may be made in this way with very much greater dispersion than a quartz instrument of the same size. E. C. C. B.

1204. *Electrons and the Absorption of Light.* **R. A. Houstoun.** (Nature, 80. pp. 338–339, May 20, 1909.)—On the theories of dispersion of Drude and

Lorentz an absorption band in a spectrum corresponds with the free period of an electron, and, assuming that only one electron in each molecule is concerned with an absorption band, the value of *e/m* for this electron is expressed in terms of the max. value of the coefficient of extinction $\bar{k}$ for the band by: $(e/m) = 1{\cdot}297\, \nu\bar{k}\, (\lambda_1 - \lambda_0)/\lambda_0^2$, where ν is the refractive index, λ_1 is the wave-length for which the coefficient of extinction has a value equal to half its maximum, and λ_0 is the position of the maximum. A table of calculated results is given from which it appears that for the anilin colouring matters *e/m* is of the order 10^7, whereas for glasses and inorganic salts it is of the order 10^4 and under, showing that in the one case electrons are active, and in the other ions. The results cannot be obtained on Planck's theory. G. E. A.

1205. *Dispersion of Ethylene and Ethane.* **S. Loria.** (Acad. Sci. Cracovie, Bull. 2. pp. 195–207, Feb., 1909. Ann. d. Physik, 29. 3. pp. 605–622, June 10, 1909. Extract.)—The dispersion of the gases mentioned, in the visible spectrum, is measured by a method similar to that previously described [Abstract No. 684 (1909)], and the refractive indices are found for values of the wave-length between $6{\cdot}677 \times 10^{-5}$ and $5{\cdot}280 \times 10^{-5}$ cm., *e.g.*, that of ethylene for the D_1 line, and at 0° and 760 mm. pressure is 1·0006571, and the index for ethane under similar conditions is 1·0007528. The Cauchy constants are also calculated. The results of the two papers are applied to the theory of dispersion, particularly to the assumption of mono-electronic constitution for gaseous non-conductors. The models of atomic structure as advanced by W. Natanson and J. J. Thomson are compared, and it is considered that the attempts of theory (at least in its simplest forms) to compass a relation between "dispersion" electrons and "valency" electrons have not the support of experiment in the case of the gaseous hydrocarbons. G. E. A.

1206. *Determination of the Principal Section of Crystal Plates.* **G. Meslin.** (Annal. Chim. Phys. 17. pp. 140–144, May, 1909.)—When a crystalline plate is placed between a crossed polariser and analyser, with its principal directions at 45° to the sections of the analyser, if the lamina is successively rotated round these two directions, the axis is that one of them round which this movement of rotation raises the tint in the chromatic scale. This rule applies also to biaxial crystals, and a mathematical proof for this class of crystals is given, the cases considered being a plate cut perpendicular to one of the bisectors of the optic axes, and one cut parallel to the plane containing the optic axes. G. E. A.

1207. *Young's Chromatic Circle.* **A. Rosenstiehl.** (Comptes Rendus, 148. pp. 1312–1315, May 17, 1909.)—Treats of the placing of the various colours in a circle, dwelling specially upon which pairs are complementary; orange being given as complementary to the first green-blue, the third yellow-green being complementary to the first violet, and the third blue to a yellow between the first and second. E. H. B.

1208. *International Unit of Light.* **R. T. Glazebrook.** (Nature, 80. pp. 374–375, May 27, 1909. Illumin. Engin., London, 2. p. 398, June, 1909. Elect. Rev. and West. Electn. 54. pp. 1128–1129, June 19, 1909.)—An important announcement regarding the proposed international unit of light, referred to in a circular issued by the Bureau of Standards (No. 15, April 1, 1909) and now authoritatively published by the National Physical Laboratory. The relations between the unit of light in use in Great Britain, France, Germany, and the United States are summarised. The units in use in Great Britain and France are in practical agreement, but that employed in the United States is 1·6 per cent. higher than this value. It is now proposed that the United States reduce their unit so that it may be in equality with that of France and Great Britain, and this suggestion has been approved by the laboratories in these three countries. The Hefner-candle maintained in Germany will now be expressed as the round figure of 0·9 of the proposed international unit. From April 1, 1909, onwards the following simple relations hold good :—

Proposed new unit = 1 pentane candle.
= 1 bougie decimale.
= 1 American candle.
= 1·11 Hefner unit.
= 0·104 Carcel unit.

The proposal to call the common unit of light, to be maintained jointly by the national standardising laboratories of America, France, and Great Britain, the "international candle" has been submitted to the International Electrotechnical Commission, and it is hoped that general approval will be secured, and that in the near future the term "International candle" for the new unit will have official international sanction. L. G.

1209. *Absolute Sensibility of AgBr Gelatine Plates to Light of Different Wave-lengths.* **G. Leimbach.** (Zeitschr. wiss. Phot. 7. No. 5. pp. 157–178, April, and pp. 181–206, May, 1909.)—The Bunsen-Roscoe law $il = const.$ for equal blackening effect does not apply ; the Schwarzschild law $it^p = const.$ does, where $p = 0{\cdot}87$ for Schleussner plates, 0·95 for Lumière's Σ plates, 0·85 for Perorto plates, and 0·86 for Agfa chromo-isolars. The gradation under normal exposures does not vary with the wave-length. The amount of energy required for a sufficient practical density (log. opacity = 1·5) at the point of max. sensitiveness ($\lambda = 450\ \mu\mu$) is for Schleussner plates 10·5, for Σ plates 1·88, for Perorto 16·8, and for chromo-isolar 17·8 times 10^{-10} watt-sec./cm.^{2}. Comparative measurements were made with a Nernst and a Hefner lamp, which enable the readings of exposure-meters to be translated into absolute units. A. D.

1210. *Photographic Printing.* **E. E. Fournier d'Albe.** (Roy. Dublin Soc., Proc. 12. 11. pp. 97–100, May, 1909.)—A method of printing on a plate by laying the original under the plate, passing light through the plate and relying on the 5 per cent. differences of reflecting power in the original. A thin copy may be obtained, which may be intensified. A. D.

1211. *Magnetic Circular Polarisation in Metals.* **H. Behrens.** (Zeitschr. wiss. Phot. 7. pp. 207–219, May, and pp. 221–245, June, 1909.)—The magnetic rotation measured by Kundt and others is examined by means of mirrors of the magnetic metals produced by kathodic pulverisation. Mirrors of Ni, Mn, and Cr gave no rotation ; for the metals Fe and Co the following results are given : The maximum rotation for iron per unit of length with green light ($\lambda = 577\ \mu\mu$) is 206,000°, and for cobalt 197,000°. The dispersion of rotation is anomalous in both metals, *i.e.*, the red rays are rotated more than the violet. The dispersion in iron can be represented by $\phi^2 = 10{\cdot}6 - 272/(\lambda^2 + 11{\cdot}8)$, and in cobalt by $\phi^2 = 802/(109 - \lambda^2)$. The law of Du Bois, that the magnetic rotation for radiant energy of all wave-lengths is proportional to the magnetisation, was verified for various regions of the spectrum. Both metals have a max. rotation for a certain intensity of field which varies with each mirror; on the average it is 6,000 gauss for iron, and 4,500 for cobalt. G. E. A.

1212. *Anomalous Dispersion in the Magnetic Rotation of Polarised Light.* **G. J. Elias.** (Deutsch. Phys. Gesell., Verh. 11. 9. pp. 207–210, May 15, 1909.)—A continuation of the work previously described [see Abstract No. 488 (1909)] using solutions of the salts of the rare earths. Photometric measurements show considerable changes in the relative magnitudes of the absorption maxima, but there is disagreement between these observations and those obtained spectrophotometrically. The explanation for this difference is not known, but the author places greater faith in the former, since an accurate knowledge of the absorption curve alone can give trustworthy readings of the position of the absorption maximum. Measurements were also made of the magnetic rotation of the plane of polarisation, and anomalies were always to be noted in the neighbourhood of an absorption band. The position of the absorption maxima and minima are independent of the concentration and acid content with a given solution. Certain deviations were noted from strict proportionality with the field strength. With decrease of temperature a strong increase in the rotation itself and also in the anomalies was observed, the increase in the latter being often in inverse proportion to the absolute temperature. The Voigt type of rotation curve appeared in a few cases approximately to hold good, but in most cases the Drude type, although again generally only approximately. E. C. C. B.

1213. *Absorption Spectra.* **S. H. Wratten** and **C. E. K. Mees.** (Photographic Journ. 49. pp. 235–247; Discussion, pp. 247–249, May, 1909.)—Experimental methods for obtaining absorption spectra; record of spectra of a large number of the more recent dye-stuffs; properties of dyes which render them suitable for filter-making; particular absorptions in special regions of the spectrum; certain peculiar results obtained by dividing the spectrum otherwise than into three consecutive portions. The strongest source of purely monochromatic light known is a mercury-vapour lamp, the rays of which traverse a filter composed of a strong yellow film between two pieces of didymium glass not more than 1 cm. in thickness; only the green line is transmitted, and this almost undiminished. A. D.

1214. *Relation between Absorption Spectra and Chemical Constitution.* Part XII. *Some Amino-aldehydes and -ketones of the Aromatic Series.* **E. C. C. Baly** and **E. G. Marsden.** (Chem. Soc., Journ. 93. pp. 2108–2118, Dec., 1908.)—In the amino-aldehydes and -ketones examined, there are two well-defined influences brought simultaneously to bear on the phenyl group, viz., firstly the ketonic oxygen in the β-position tending to restrain the motions of the phenyl group, and secondly the amino group with an influence of exactly the opposite nature. Inasmuch as the absorption curves of these compounds all show large absorption bands, it is evident that the restraining influence of the ketonic or aldehydic group is more than counteracted by the amino group. D. H. J.

1215. *Ultra-violet Absorption Spectra of certain Metallic Vapours and their Mixtures.* **R. W. Wood** and **D. V. Guthrie.** (Astrophys. Journ. 29. pp. 211–228, April, 1909.)—The absorption spectra of Cd and Tl in the state of vapour have been investigated in the ultra-violet region, both in the pure state and also mixed with definite amounts of Hg vapour. The metals were heated in a silica bulb, the temperature being measured by means of a Pt-Rh couple. In the case of Cd two absorption bands were noted at λ = 2288 and λ = 3261, the former being much the more prominent. When the vapour was pure the line λ = 2288 was found to broaden symmetrically, but the addition of Hg vapour caused the broadening to take place much more on the less refrangible side. Four bands were observed with pure Tl vapour, at λ = 2380, λ = 2580 (nearly), λ = 3092 (nearly), and λ = 3230; the last three disappear when plenty of Hg vapour is present, and other bands appear, amongst which occur bands at λ = 2580, λ = 2768, and λ = 3776. With small quantities of Hg the first four bands are stronger than with pure Tl vapour. The bands show generally marked asymmetrical broadening, especially λ = 2768 and λ = 3776, on the less refrangible side. E. C. C. B.

1216. *Changes in the Spectrum of the Singing Arc.* **M. La Rosa.** (Ann. d. Physik, 29. 2. pp. 249–276, May 21, 1909. From the Physikal. Inst. d. Kgl. Univ., Palermo. N. Cimento, 17. pp. 208–228, April, 1909.)—An investigation into the changes which occur in the spectrum of the singing arc as the electrical conditions are varied. The results may be briefly stated by saying that if the self-inductance be kept constant and the capacity of the condenser be increased the spectrum steadily changes from that of the arc to that of the spark. The author considers that the latter is due to a higher degree of excitation, and that the changes from one type to the other depends upon the amount of work done in the circuit. This work is the only parameter which determines the type of spectrum. E. C. C. B.

1217. *Arc Spectrum of Yttrium.* **G. Eberhard.** (Zeitschr. wiss. Phot. 7. pp. 245–258, June, 1909.)—A measurement of the wave-lengths of the lines of the arc spectrum of yttrium between the limits λ = 4528 and λ = 2760. Comparison is made with the previous values given by Kayser and by Exner and Haschek, the agreement between the present values and those of Kayser being very good after the introduction of a systematic correction.

E. C. C. B.

1218. *The Magnesium Spectrum under reduced Pressure.* **E. E. Brooks.** (Astrophys. Journ. 29. pp. 177–189, April, 1909.)—An extension of the author's previous work upon the Mg spectrum in partial vacua [see Abstract No. 779 (1908)], chiefly to investigate the mode of occurrence of the so-called hydride spectrum. A direct current was employed as follows: The current from a 2,000-volt transformer was rectified by means of a battery of 48 lead-aluminium cells arranged in four groups to make use of each half-period. Two types of discharge in an atmosphere of hydrogen may be recognised, viz., the kathode discharge and the eruptive or jet discharge. The first has two prominent characteristics—(1) the kathode gets hot, and (2) the hydride spectrum is absent. The second occurs in all gases, and in this case the kathode is cool and the hydride spectrum is strong if only the merest trace of hydrogen or water be present. As regards the origin of the hydride spectrum, the author draws the following conclusions from his experiments: (1) The spectrum represents some transitional and unstable state; (2) its production depends far more on the nature of the discharge than upon the quantity of hydrogen present, although the presence of this gas in some form appears to be necessary; (3) a trace of water is even more effective than hydrogen, but its presence is not essential; (4) if a hydride compound exists it is probably decomposed as fast as it is formed. The necessity for the presence of hydrogen is the only evidence that the hydride spectrum is due to a compound. E. C. C. B.

1219. *Emission Spectrum of Silver heated in a Carbon-tube Furnace in Air.* **W. G. Duffield** and **R. Rossi.** (Astrophys. Journ. 28. pp. 371–378, Dec., 1908.)—A carbon tube 12 in. long and ⅝ in. wide was electrically heated and the silver was carried in a small boat placed in the centre of the tube. The spectrum was examined both visually and photographically with a 1-m. grating instrument. Very little trouble was experienced from impurities, owing to the fact that a higher temperature was required to bring them out than sufficed for the silver. About 70 lines were measured between $\lambda = 5061$ and $\lambda = 4100$, and, further, 25 flutings of doubtful origin were measured upon the photographs between $\lambda = 5749$ and $\lambda = 5878$. E. C. C. B.

1220. *Influence of Impurities on the Doppler-effect in the Spectrum of the Canal Rays in Hydrogen.* **B. Strasser.** (Phys. Zeitschr. 10. pp. 404–405, June 15, 1909.)—Experiments have shown that when the canal-ray spectrum is observed along the path of the rays, the spectrum line is seen to be double, one part being shifted by the Doppler-effect and the other part being in the original position of the undisturbed line, the two portions being separated by a region of minimum intensity. The author now shows this effect to be due to the admixture of impurities, for in the case of pure hydrogen only the shifted line is visible; but the introduction of impurities at once causes the resting portion to appear with greater and greater intensity until the shifted portion vanishes altogether. The influence exerted depends directly upon the atomic weight of the impurity, and the same effect is produced by gases such as He, A, N_2, and also by the particles shot off from a disintegrating electrode. In reference to the last, the effect of the disintegrating electrode decreases with time, so that a tube carrying such an electrode eventually gives the same spectrum as one with Al electrodes which do not disintegrate at all. E. C. C. B.

1221. *Asymmetries in Position and Intensity of the Magnetic Components of Emission Rays. A New Type of Position Asymmetry.* **A. Dufour.** (Comptes Rendus, 148. pp. 1594–1596, June 14, 1909.)—The author has examined in a powerful magnetic field the resolution of certain of the emission lines of Cr, the observations being made both parallel and perpendicular to the lines of force. Twelve rays were investigated, and it was found that the same symmetry or asymmetry in position or intensity appeared both qualitatively and quantitatively whether the observations were made parallel or perpendicular to the lines of force. In the case of the lines $\lambda = 5206{\cdot}20$ and $\lambda = 5208{\cdot}40$ there appeared to be perfect symmetry in position and intensity of the components in reference to the undisturbed line. With the line $\lambda = 5348{\cdot}31$ the symmetry of position is preserved, but the components on the blue side are more intense than the others. For the other rays, *e.g.*, $\lambda = 5204{\cdot}49$ and $\lambda = 5247{\cdot}56$, the Zeeman group is not symmetrical to the undisturbed line, but to a line shifted towards the blue. Finally, the line $\lambda = 5264{\cdot}15$ is abnormal; it gives a sextuplet formed of a doublet D for the parallel vibrations and a quadruplet for the others. The latter is formed of two doublets, d_1 and d_2, of different displacements. The means of d_1 and d_2 have a displacement double the normal, while D has the normal displacement.

The sum of the displacements of d_1 and d_2 appear to be equal to that of D, and finally D and the means of d_1 and d_2 have the same axis of symmetry, shifted towards the violet in reference to the original position of the line.

E. C. C. B.

1222. *An Example of a completely positive Longitudinal Zeeman-effect.* **A. Dufour.** (Comptes Rendus, 148. pp. 1311–1312, May 17, 1909.)—As the author has pointed out previously, when an abnormal longitudinal Zeeman doublet is examined with the circular analyser there generally remains what he has called a residue of polarisation. He now shows that in the case of the band of Fe_2O_3 at $\lambda = 5790$, which is abnormal, the circular polarisation seems to be complete.

E. C. C. B.

1223. *Polarisation of Röntgen Rays.* **E. Bassler.** (Ann. d. Physik, 28. 4. pp. 808–834, March 16, 1909. Extract from Dissertation, München, 1908.)—After a short account of the work of Blondlot, Barkla, and other observers on this subject the author gives an elaborate description of his own researches which were carried out by electrical and photographic arrangements. The chief results deduced from his observations are as follows: (1) Through the ionising action of the secondary radiation of gaseous, liquid, and solid substances a partial polarisation of the primary Röntgen rays may be proved. Of a great number of substances investigated the best radiator, or source of secondary rays, turned out to be a ball of paraffin, whilst the most inefficient was a ball of lead. (2) With medium soft primary rays paraffin exhibits 10 per cent. polarisation, *i.e.*, if with no polarisation in a certain direction the secondary radiation was 100 units, in consequence of polarisation its intensity parallel to the kathode rays would be 90 units, and perpendicular thereto 110 units. (3) The harder the *x*-ray tube the smaller polarisation can the radiator exhibit and the greater is the intensity of the secondary rays, yet the hardest rays still show polarisation. (4) Al shows 5 per cent. polarisation with medium soft rays. With lead the polarisation cannot be proved with full certainty. (5) Paraffined lead exhibits the more polarisation the thicker the layer of paraffin is: with a layer 0·25 mm. thick it is already noticeable. (6) The secondary radiation of paraffin comes for the most part from the interior, not from the surface. (7) Secondary rays, which the radiator emits obliquely to the axis of the primary rays, exhibit less polarisation than those emitted perpendicularly. (8) When media of considerable absorbing power, such as Pt, Cu, or water, are inserted in the path of the primary rays the paraffin radiator shows an increase of the polarisation of the penetrating Röntgen rays up to doubled values. (9) The polarisation does not depend on the angle between the radiating surface and the surface on which the rays fall. (10) The polarisation increases with the azimuth between 80° and 90°; for azimuths greater than 90° the polarisation does not decrease, but appears to have a maximum at about 110°. (11) The polarisation and its change with the azimuth varies in the case of different tubes of equal hardness, but remains of the same order of magnitude. (12) The intensity of the Röntgen rays outside the tube—measured by the secondary radiation—showed itself at the surface on which they fell to be strongly dependent upon the azimuth. (13) Negative results were obtained in all the attempts to observe the polarisation of the primary Röntgen rays photographically through the action of the secondary radiation on films and plates. (14) An explanation of the failure of result in the investigation by aid of photography is indicated by the influence of the absorbing medium of the radiating substance and of the hardness of the rays on the amount of polarisation, with help of the selective absorption and of a special consideration of the mechanism of the origin of the Röntgen rays. J. J. S.

1224. *Deflection of Röntgen Rays.* **B. Walter** and **R. Pohl.** (Ann. d. Physik, 29. 2. pp. 831–854, May 21, 1909. Physikal. Staatslaborat., Hamburg, 1909.)—A detailed description with diagrams is given of the arrangement of the apparatus for carrying out experiments to ascertain whether Röntgen rays can be deflected, and also a full account of some such experiments. It is contended that the experiments do not prove that it is possible to deflect the rays, hence the wave nature of the rays receives no support by researches in this direction. Still their wave nature is taken for granted on other grounds, and the experiments show that the wave-length must be less than $1{\cdot}2 \times 10^{-9}$ cm., for a sufficiently small bundle of rays from a slit $2\,\mu$ in width is able to form an image which shows no deflection on a photographic plate 80 cm. distant. The wave-length when obtained from the velocity of the secondary kathode rays by applying Planck's theory is at the lowest estimation $4{\cdot}5 \times 10^{-9}$ cm. There thus exists between that theory and these researches an unexplained disagreement. A. E. G.

1225. *Röntgen Rays from a Tube with magnetically deflected Kathode Focus.* **J. H. Gardiner.** (Röntgen Soc., Journ. 5. pp. 80–81, May, 1909.)—Experiments are described which show that the life of a Röntgen-ray tube can be lengthened by deflecting the kathode rays by means of a small magnet, so that they come to a focus on different parts of the antikathode. The radiograms obtained under these conditions are quite satisfactory as regards both definition and density. A. E. G.

1226. *Want of Symmetry shown by Secondary Röntgen Rays.* **W. H. Bragg** and **J. L. Glasson.** (Phil. Mag. 17. pp. 855–864, June, 1909. From Roy. Soc. of South Australia, Transactions, Vol. 32, 1908.)—J. J. Thomson has shown, on the assumption that Röntgen rays consist of ether pulses, that it is possible to account for the existence of secondary Röntgen rays by assuming that the primary pulses set in motion electrons over which they pass, and cause them to become new centres of radiation. Now if an electron becomes such a centre of radiation, the intensity of the secondary effect must be symmetrical about the line of motion of the electron. The experiments described are made with the object of examining the secondary Röntgen rays excited by primary Röntgen rays. It is found that in general a want of symmetry exists; that it is sometimes very pronounced; and that it is in keeping with expectation based upon Madsen's study of secondary γ-rays. The proportion of emergence to incidence radiation differs considerably for the different radiators, but is much the same for different screens, or different thicknesses of screen, except that the proportion tends to increase slightly as the screen is made thicker; and the tendency is most pronounced in the case of those metals which give out a quantity of soft secondary radiation. The emergence secondary rays are generally in excess of the incidence. This is another instance of the close parallelism between Röntgen and γ-rays. On the material theory of Röntgen and γ-rays the effect is easily explained, and is to be classed with the scattering to which β- and α-rays are subject. From the experiments it is also concluded that very hard γ-rays follow a density law of absorption, treating all atoms alike except in respect to weight. Soft γ-rays are not independent of the atomic grouping of matter, and are far more strongly absorbed by heavy atoms than by light after allowance has been made for weight. The same is generally true for Röntgen rays; but in the case of very soft Röntgen rays there is a tendency to revert to the density law again. A. E. G.

1227. *Secondary Röntgen Radiation from Air and Ethyl Bromide.* **J. A. Crowther.** (Cambridge Phil. Soc., Proc. 15. pp. 101–105, May 21, 1909.)—The rays from ethyl bromide are much softer than those from air, and Bragg has suggested that this may account for the startling results obtained in the case of compounds containing arsenic and bromine [see preceding Abstract]. In the light of this suggestion it has been thought desirable to make some direct experiments to compare the relative amounts of ionisation produced by the secondary rays from ethyl bromide and from air in some gas not so unfavourable as air to the harder radiations. For this purpose the amounts of ionisation produced in ethyl bromide by the secondary rays from ethyl bromide and from air are investigated. The apparatus, of which a diagram is given, is a modified form of that used in previous researches on this subject. The relative amounts of ionisation are measured. From these, knowing the absorption of ethyl bromide for the two kinds of secondary rays, the relative intensity of the secondary radiation from ethyl bromide is calculated and is found to be 105 times that from air. The relative absorption of the two kinds of secondary rays is measured for a substance of low atomic weight, and the value obtained is used to correct the original results for the secondary radiation from ethyl bromide which were obtained from measurements made in air. With this correction the two values for the secondary radiation from ethyl bromide are shown to be in agreement. [See also Abstract No. 61 (1908).] A. E. G.

1228. *Condensation of the Radium Emanation.* **A. Laborde.** (Comptes Rendus, 148. pp. 1591–1593, June 14, 1909.)—In 1903 Rutherford and Soddy demonstrated that the radium emanation condensed at the temperature of liquid air is suddenly liberated when the temperature reaches −150° C. about. The present experiments are undertaken to ascertain whether the nature of the walls of the tube in which the emanation is condensed has any effect upon the temperature at which this liberation takes place. For this purpose Cu, Fe, Sn, Ag, glass, and silvered glass vessels are used. In all the metals examined the emanation is liberated at the same temperature, viz., −158° to −155° C. In glass and silvered glass vessels the liberation takes place at 20° to 24° lower. These experiments are carried out with widely differing amount of emanation. The behaviour of the emanation in the presence of bodies known to be able to absorb gases, such as wood charcoal, talc, platinum black, spongy Pt, and cocoa-nut charcoal is next tested. With these, except in the case of spongy Pt, the liberation takes place much more slowly, and also at a slightly higher temperature. From the results obtained it is deduced that the nature of the walls plays an important part in the liberation of the emanation. It is not, however, possible to say that absorption by the walls is the principal factor, yet may it not be true that all bodies possess the property of absorbing the emanation of radium but do so at different temperatures? A. E. G.

1229. *Absorption of γ-rays from Radium by Lead.* **Y. Tuomikoski.** (Phys. Zeitschr. 10. pp. 372–374, June 1, 1909. Phys. Lab., Manchester Univ., 1909.)—The researches of Rutherford, McClelland, Wigger, and Eve show that the exponential law for absorption of the γ-rays holds only when they have already passed through 1–2 cm. of lead. The present research is undertaken to test the absorption after passing through still greater thicknesses. The source of the rays is radium emanation contained in a glass tube, and the action of the rays could still be measured after they had passed through 19 cm. of Pb. Lead plates 2–3 mm. in thickness were used as absorbers, and these plates were sufficiently large to secure that all rays entering the electroscope should pass through them. It is found that the rays, after passing through a considerable thickness of Pb, do not diminish exponentially with an increasing thickness of absorbers. After about 1·5 cm. of Pb the decrease is exponential until a thickness of 12 cm. is reached. Within this limit $\lambda = 0{\cdot}52$ to 0·50. The latter part of the curve given shows two marked changes in slope, one occurring with a layer 12 cm. in thickness, and the other when the thickness is 15·7 cm., and λ for these has the values 0·37 and 0·25 respectively. It seems also that it is possible that after passing through 18·8 cm. of Pb there is a still further decrease in the value of λ. This point is being investigated, as is also the absorption due to other substances.

A. E. G.

1230. *Nature of the Ionisation produced in a Gas by γ-Rays.* **R. D. Kleeman.** (Cambridge Phil. Soc., Proc. 15. pp. 169–177, May 21, 1909.)—The ionisation in a chamber placed in the path of γ-rays may consist of three parts: (*a*) ions ejected by the γ-rays from the gas molecules with a velocity which is so small that they are unable to produce any further ions themselves, (*b*) ions made by the kathode rays from the walls of the chamber, and (*c*) ions made by kathode rays of high velocity ejected from the gas molecules. The first and second of these are proportional to the pressure, while the third is proportional to the square of the pressure. The author has shown that the γ-rays give rise to secondary kathode rays of very different velocities; some of these rays have a range in air at atmospheric pressure of the order 2 cm., while some are as penetrating as the penetrating β-rays of Ra. It cannot be assumed, therefore, that the absorption of the rays as a whole is the same as the β-rays of Ur, or the penetrating β-rays of Ra. Now, since the attempts which have been made to estimate the amount of ionisation in a chamber which is not due to radiation from the walls, depend for their accuracy on calculations based on assumptions involving a knowledge of the absorption, ionisation, &c., of the kathode rays produced by the γ-rays, they are by no means satisfactory. It is not at all certain that the total ionisation is not entirely due to the secondary radiation from the walls—hence direct experiments are now made to test this point. Several slightly different arrangements are now used, each of which involves the deflection of the secondary radiation from the apparatus by means of a magnetic field; these are described with diagrams. From the experiments it appears that the ionisation in a chamber is due in part to the direct action of the γ-rays on the gas it contains. Since Laby and Kaye have shown that the amount of ionisation produced by the secondary γ- and β-rays from the gas is small, this ionisation consists of slow-moving β-rays ejected by the γ-rays, which have not sufficient velocity to produce any further ionisation themselves. The ratio of this part of the ionisation in a chamber to that produced by radiation from its walls will depend on the ratio of the total inside surface of the walls of the chamber to its volume, and on other conditions. The present experiments suggest that in most cases this ratio will be greater than ½. It is also calculated from results obtained that the number of δ-rays produced per sec.

directly by 1 gm. of Ra is equal to 4·4 × 10^{14}. The ionisation of a gas in a chamber exposed to β-rays may be divided into two parts: (*a*) slow-moving δ-rays produced directly by the primary β-rays, and the secondary β-rays from the walls of the chamber, and (*b*) ionisation produced by β-rays of high velocity ejected from the molecules of the gas. The first is proportional to the pressure, and the second to the square of the pressure. Now Strutt has shown that the ionisation produced in a gas by β-rays is proportional to the pressure over a wide range of pressures, therefore the second part of the ionisation is small in comparison with the first, so that the β-rays also produce directly, rays which do not themselves possess sufficient velocity to make any further ions. Thus the ionisation of a gas by γ-, β-, and Röntgen-rays is a measure of the number of δ-rays produced directly by the ionising agent.
A. E. G.

1231. *Experiment on Ionisation with γ-Rays.* **L. Vegard.** (Cambridge Phil. Soc., Proc. 15. pp. 78–81, May 21, 1909.)—The object of the experiment is to ascertain whether the ionisation by γ-rays is strictly an additive property. The γ-radiation used comes from two Ra sources; one of these could be placed in a fixed position, the other on a movable arm capable of rotating about a vertical axis coinciding with the axis of the ionising cylinder. Results of experiments are given in tables, and these show that within the limits of experimental error the ionisation of air with γ-rays is strictly an additive property.
A. E. G.

1232. *Relative Amounts of Radium and Uranium in Radio-active Minerals.* **E. Gleditsch.** (Comptes Rendus, 148. pp. 1451–1453, June 1, 1909.)—It is generally admitted that a constant ratio exists between the quantities of Ur and Ra contained by the radio-active minerals. McCoy, Eve, Strutt, Boltwood, and Rutherford have all contributed work which points to that conclusion. In the present experiments the radium content is determined by a method differing from those previously employed, in that the Ra is first of all separated from the mineral and then examined. The amount of the Ur contained is ascertained after the Ra has been removed. It is found that the ratio Ra/Ur is not constant for the following minerals: French autunite, Joachimsthal pitchblende, and Ceylon thorianite. The quantities found in the case of pitchblende are in accord with those obtained by Boltwood, but the amount of Ra associated with 1 gm. of Ur is relatively smaller in autunite and larger in thorianite. The method employed, of which details are given, is being examined more rigidly in order to ascertain, if possible, the reason for the divergence between the results now obtained and those of Boltwood. Other minerals are also being examined.
A. E. G.

1233. *Production of Radium from Uranium.* **F. Soddy.** (Nature, 80. pp. 308–309, May 13, 1909.)—With carefully purified uranium salts, using considerable quantities, the growth of radium is too small to be detected for the first 2 or 3 years, and is less than 1/10000th of what would occur if a direct change of Ur into Ra took place. On the other hand, with commercial uranyl nitrate purified from Ra a distinct production of Ra is observed [see Abstract No. 1956 (1908)]. This is explained by the presence of ionium. The production of Ra is now established in all solutions of carefully purified uranyl nitrate prepared by T. D. Mackenzie and the author [Abstract No. 1642 (1907)]. The mode of testing is much improved, and the error of a single determination does not probably exceed 10^{-12} gm. of Ra. The quantity of

Ra in the oldest solution is now about 4×10^{-11} gm., which is nearly twice as great as initially. Measurements made on this specimen during the last 5 years show that the production of Ra has proceeded during that period proportionally to the square of the time. Rutherford has shown mathematically that such a law should apply in this case, on the assumption that there is only one intermediate substance in the uranium-radium series of period of life, long compared with the time of experiment. Hence these experiments indicate that there is only one such intermediate substance. Certain considerations make it appear probable that the average life of this intermediate body is 10,000 years, and that there should exist in uranium minerals about 1·86 mgm. of the substance per kg. of Ur. A. E. G.

1234. *Production of Strong Radio-active Bodies from Uranium and its Compounds.* (D.R.-P. No. 208,809. Elektrotechnik u. Maschinenbau, 27. p. 505, May 23, 1909. Abstract.)—The radio-active transformations which take place in uranium and its compounds can be much accelerated by exposing them to the action of Röntgen rays, or, better still, to that of kathode rays. The exposure must be of sufficient duration, and the gases evolved during the process must be continually removed, a high vacuum being maintained. A. P. H. Trivelli states that in this relatively inexpensive manner substances whose activity approximates to that of the more costly radium preparations can be obtained. A. E. G.

1235. *Liberation of Helium from Radio-active Minerals by Grinding.* **J. A. Gray.** (Roy. Soc., Proc. Ser. A. 82. pp. 301–306, May 26, 1909.)—It is almost certain that the helium in radio-active minerals is mechanically retained rather than chemically combined. These experiments are an investigation into the size of the structure which retains the He atoms. Moss has found that traces of He can be liberated from pitchblende by grinding, and it seemed likely that, by pushing much further, a large percentage, if not the whole, of the He might be liberated. If so, it would be legitimate to conclude that the structure in which the He atoms are entangled is of the same order of magnitude as the particles of powder. The experiments are carried out on Ceylon thorianite. To determine how much He is liberated by grinding, the amount of He per gm. of normal mineral is found, and also the amount per gm. contained in the ground mineral; the difference gives the amount liberated. A detailed account of the method of performing the experiment is given. The following results are obtained. It is difficult to say at what size the liberation of He begins; it is probably in the neighbourhood of 5μ. About 28 per cent. of the He present has been liberated by grinding. The smaller the mineral is ground, the more He is liberated. The liberation has a temporary limit when the mineral is reduced to a size of about 3μ. It is impossible to say how the remaining 72 per cent. of He is contained in the mineral. A. E. G.

REFERENCES.

1236. *Relation between Absorption Spectra and Chemical Constitution. XI. Some Aromatic Hydrocarbons.* **E. C. C. Baly** and **W. B. Tuck.** (Chem. Soc., Journ. 93. pp. 1902–1914, Nov., 1908.)—An examination of the absorption spectra of naphthalene, acenaphthene, acenaphthylene, fluorene, chrysene, anthracene, phenanthrene, diphenyl, and dibenzyl, and a discussion of the relation between the observed spectra and the chemical composition. D. H. J.

1237. *The Hammer-Fennel Topometer.* **E. Hammer.** (Zeitschr. Instrumentenk. 29. pp. 129–137, May, 1909.)—A second instrument of the type described in Abstracts Nos. 827 and 2018 (1902) for the automatic and simultaneous measurement of distances and differences of level is fully described with the aid of diagrams and a photograph. G. E. A.

1238. *The Discovery of the Ultra-microscopic Method.* **C. V. Raman.** (Phil. Mag. 17. p. 495, April, 1909.)—Calls attention to a description of an ultramicroscope by G. Dubern in "Indian Engineering" of 1888.

1239. *Photography of Small Objects on Enlarged Scale.* **A. Mallock.** (Roy. Soc., Proc. Ser. A. 82. pp. 181–183, May 6, 1909.)—Investigation of the depth of focus and aperture for best definition. A. D.

1240. *Sulphide Toning of Bromide Prints.* **H. W. Bennett.** (Photographic Journ. 49. pp. 280–284 ; Discussion, pp. 284–287, June, 1909.)—Method, with details, for securing a definite range of brown to black tones by the addition of mercury to the bleaching solution. A. D.

1241. *Sensitising AgCl-gelatine.* **J. M. Eder.** (Zeitschr. wiss. Phot. 7. pp. 253–256, June, 1909.)—Experimental errors in Wentzel's work [Abstract No. 815 (1909)] are pointed out, arising from the use of flint-glass prisms. Priority is also claimed. A. D.

1242. *Optics of Colloidal Metal Solutions.* **R. Gans** and **H. Happel.** (Ann. d. Physik, 29. 2. pp. 277–300, May 21, 1909. Physikal. Inst., Tübingen, March 11, 1909.)—A mathematical treatment is first given, in which Mie's work is extended [see Abstract No. 594 (1908)], and a method is given by means of which the absorption coefficient and dispersion curve can be calculated ; the results are applicable to concentrated solutions. Two special cases are then discussed—that of an infinitely dilute solution with particles of variable size, and that of a solution of variable concentration containing infinitely small particles. G. E. A.

1243. *Calcium Lines in Electric Furnace Spectra.* **A. S. King.** (Mount Wilson Solar Observatory, Contribution No. 32. Nature, 80. p. 260, April 29, 1909. Abstract.)—Discussion of the behaviour of the chief lines of calcium with respect to the spectrum given by the electric furnace and the solar chromosphere. [See Abstract No. 1414 (1908).] C. P. B.

1244. *Wave-lengths of Lines in the Secondary Spectrum of Hydrogen.* **H. E. Watson.** (Roy. Soc., Proc. Ser. A. 82. pp. 189–204, May 6, 1909.)—A complete series of measurements of the secondary spectrum of hydrogen between the limits $\lambda=6563$ and $\lambda=2483$ as photographed with a grating of 10 ft. focus and 14,438 lines to 1 in. As standards Kayser's normal iron wave-lengths were used, no attempt being made to reduce them to absolute values. E. C. C. B.

1245. *The Absorption of certain Ethereal Oils in the Ultra-violet.* **A. Pflüger.** (Phys. Zeitschr. 10. p. 406, June 15, 1909.)—The author has examined with a mercury lamp and a thermo-couple the absorptive power of many ethereal oils in order to find a substance less absorptive than glycerine. The results are given in the paper, but all the oils examined show considerable absorption. E. C. C. B.

1246. *Argon as a Companion of Radio-active Zirconium Minerals.* **A. v. Antropoff.** (Zeitschr. Elektrochem. 15. pp. 144–145, March 1, 1909.)—Hahn has suggested (Zeitschr. Elektrochem. 15. p. 50, 1909) that the argon found in the zirconium mineral malakon [see Abstract No. 1810 (1908)], was derived from the atmosphere, but the author maintains that the amount was too great to be accounted for in this way. T. H. P.

HEAT.

1247. *Féry Spiral Pyrometer.* (Engineering, 87. p. 668, May 14, 1909.)—The heat rays from the hot body are reflected by a concave mirror upon a very small spiral strip made up of two metals of different coefficients of expansion, which unrolls when heated, carrying a pointer over a scale. The concave mirror is focussed upon the spiral by observing through an eyepiece the reflection of the hot body in a plane mirror consisting of a pair of wedges. The zero of the instrument is set before each reading. If left in position, the instrument as a whole gets hotter and the zero must again be corrected. Comparison results with this instrument and a thermo-electric Féry radiation pyrometer up to 1,250° C. gave differences of from −5° to +10°. At present instruments are made of three different ranges, viz., from 500° C. to 1,100°, 1,400°, and 1,700° respectively. The precautions necessarily resemble those usual with radiation pyrometers. Molten copper may appear to be as much as 100° cooler than it really is, and the instrument shows some sensitiveness to draughts. F. R.

1248. *Latent Heat of Vaporisation of Zinc.* **W. McA. Johnson.** (Amer. Electrochem. Soc., Trans. 14. pp. 251–258, 1908.)—Gives the method used for the calculation of the latent heat of vaporisation of zinc by the use of thermodynamics. The boiling-point of Zn at 760 mm. pressure is 920° C. The increase of pressure needed to keep zinc liquid for 1 deg. increase in temperature at 920° is given as 0·152 lb. per sq. in. The latent heat is calculated to be 451 cals. for 1 gm. of Zn; this compares with 388 as calculated from figures by Barus and 426 as calculated by J. W. Richards by means of Trouton's law. A similar calculation for mercury gives 61·8 cals. as compared with 62·0, the figure obtained by Person in 1846. C. O. B.

1249. *Molecular and some other Constants of the Inactive Gases.* **G. Rudorf.** (Phil. Mag. 17. pp. 795–818, June, 1909.)—The author calculates some of the molecular constants of the inactive gases in various ways, the values obtained not being in good accord. The magnitudes calculated are: (1) molecular velocity; (2) mean free path; (3) molecular diameter from (*a*) the mean free path and (*b*) the number of molecules in unit volume; (4) the number of molecules in unit volume; (5) refractive indices of the liquefied gases; (6) density of liquid neon, which is found to be 1·24, giving an atomic volume of 16. Ramsay and Travers [Abstract No. 2415 (1901)] deduced the value 20·2 from the periodic curve of the atomic volumes of the elements. The results of Sutherland and of Reinganum [Abstracts Nos. 874 and 500 (1909)] are discussed, and an error in Kelvin's paper on the sizes of atoms [Abstract No. 624 (1903)] is pointed out. T. H. P.

1250. *Possibility of Determining the Temperature of a Black Body by Means of Spectro-photometric Measurements.* **S. Pokrovskij.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 41. No. 2. pp. 78–80, 1909.)—Making use of the expressions for the sensitiveness of the eye to colour given by Goldhammer [Abstract No. 1722 (1905)] and Nutting [Abstract No. 680 (1907)], the author deduces the following expressions for determining the temperature of a black body, knowing the position of the spectro-photometric maximum in its spectrum :—

$$(1)\ \phi = [(\lambda_0/\lambda)e^{1-\lambda_0/\lambda}]^{n-4} \quad \text{and} \quad (2)\ \phi = Ce^{-a(\lambda-\lambda_0)^2};$$

ϕ represents the function of chromatic sensitiveness of the eye, λ_0 the region of greatest sensitiveness of the eye for the given brightness, n a parameter depending on λ_0 and on the individual eye, C a constant, and a a parameter depending on the brightness and on the particular eye. The law embodied in these expressions is analogous to Wien's law of displacement, and can be applied to: (1) the determination of the temperatures of stars when the positions of the photometric maxima of their spectra are known and the chromatic sensitiveness of the observer's eye has been previously studied, and to (2) the study of the function of the chromatic sensitiveness of the eye when spectro-photometric observations of the black body have been made. T. H. P.

1251. *Applications of Stefan's Law.* **C. Féry.** (Comptes Rendus, 148. pp. 1150–1152, May 3, 1909.)—In previous notes [see Abstracts Nos. 1070 and 1071 (1909)] it has been shown to what extent erroneous values are given by including certain bodies in experiments on radiant energy, and as Stefan's law is often employed for calculating the temperature of planetary surfaces it is necessary to make careful comparisons of the various corrections. The application of such corrections has a marked effect on the final value adopted for the solar constant. Recent determinations at the National Physical Laboratory gave the mean temperature of the centre of the sun as 5,158° C., while at the summit of Mt. Blanc this was recorded as 5,550° C. C. P. B.

1252. *Internal Pressure of Fluids and the Law of Intermolecular Attraction.* **E. H. Amagat.** (Comptes Rendus, 148. pp. 1135–1141, May 3, 1909.)—The author shows that the two expressions proposed to represent the so-called internal pressure of a gas, viz., $\pi = t\partial p/\partial t - p$ and $\pi' = \Sigma r\phi(r)/3v$ [compare Abstract No. 787 (1906)], appear to be in complete accord with the experimental results. The expression for π' is deduced from the relation $KT = 3pv/2 + \Sigma r\phi(r)/2$, in which $\Sigma r\phi(r)/2$ is the virial of the internal forces; this may be put into the form $KT = 3(p + \pi')v/2$, which, when applied to an isotherm, gives the expression $\pi' = \Sigma r\phi(r)/3v = p_0v_0/v - p$, the values of which are given for several gases. Admitting that the intramolecular energy depends only on the temperature, it is easy to show that the two functions π and π' are identical. The total internal pressure, $\Pi' = p_0v_0/v - p$, may be regarded as the sum of two expressions, the first being π or $t\partial p/\partial t - p$, which becomes $\Sigma r\phi(r)/3v$ for great intermolecular distances, and the second $\pi'' = \Pi' - \pi = p_0v_0/v - T\partial p/\partial t$. Two consequences of the author's results are: (1) Starting from a sufficiently large mean intermolecular distance, for sufficiently large values of the latter, the values of the function π are inversely proportional to the squares of the volumes; (2) the intermolecular attraction is inversely proportional to the fourth power of the distance. T. H. P.

1253. *Hypothesis Relative to the Nature of the Internal Pressure of Fluids.* **E. H. Amagat.** (Comptes Rendus, 148. pp. 1359–1366, May 24, 1909.)—The author has shown [see preceding Abstract] that the total internal pressure of a gas may be regarded as the sum of two pressures π and π'', the latter having the value $p_0v_0/v - t\partial p/\partial t$. The value of π'' is always negative and, for any given temperature, increases indefinitely when the volume diminishes. π'' thus acts against the molecular attraction and the external pressure, and so tends to increase the volume. This is precisely what should happen if a perfect fluid filled the intermolecular volume—an assumption which affords a ready explanation of the author's results. Since such a hypothetical fluid would be able to permeate the walls of the gas vessel, the most reasonable hypothesis is that it is retained by the matter of the gas and forms small atmospheres decreasing from the central part of each molecular grouping. Such fluid would tend to become more and more homogeneous and to obey Boyle's law more and more nearly as the pressure is increased, and this is found to accord with the results obtained with ordinary ether between 50 and 3,000 atmos. at 0°; the hypothetical fluid obeys Boyle's law from 800 atmos. upwards. T. H. P.

1254. *Internal Pressure of Gases.* **A. Leduc.** (Comptes Rendus, 148. pp. 1391–1394, May 24, 1909.)—This paper deals with the internal pressures of gases at pressures less than 8 atmos., and the author has calculated the internal pressures of a series of 18 gases under normal conditions. The law that for any gas, at constant temperature, the internal pressure is inversely proportional to the square of the specific volume [compare Amagat, Abstracts Nos. 1252 and 1253 (1909)], also holds for pressures of the order of 1 atmo. and less. Calculation of the internal pressures of ammonia and of mono-, di-, and tri-methylamines at 15° under the ordinary pressure shows that each substitution of CH_3 for H is accompanied by an increase of the internal pressure by 0·0211 atmo. The attraction between the molecules which produces the internal pressure is inversely proportional to the fourth power of their mean distance apart (compare Amagat, *loc. cit.*). This attraction might be supposed to be proportional to the square of the mass of the molecules, but the author's results show no such relation. With benzene and acetylene, however, this relation holds very nearly. T. H. P.

1255. *Researches on the Joule-Kelvin Effect, especially at Low Temperatures. I. Calculations for Hydrogen.* **J. P. Dalton.** (Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 863–873, May 24, 1909. Communication No. 109a from the Phys. Lab., Leiden.)—The criticisms of Dickson [Abstract No. 642 (1908)] on Olszewski's investigations on "inversion points" [Abstract No. 858 (1902)], being based on van der Waals' equation of state, which is not quantitatively correct, are of doubtful value. But calculation from the real isothermals of the experimental gas should give close correspondence between the calculated and experimental values of the Joule-Kelvin effect. To effect such calculations, Onnes [Abstract No. 860 (1902)] gave empirical equations of state, the product pv being expressed as a series of five powers of the density: $pv = A + B/v + C/v^2 + D/v^4 + E/v^6 + F/v^8$, where p is in atmos., v in terms of the theoretical normal volume as unit and the virial-coefficients A, B, C, &c., are calculated as functions of the temperature from the experimental isothermals of the gas in question, in conjunction with the isothermals of other substances which are brought into relation with the one investigated by means of the law of corresponding states. The above equation is hence usually given in the reduced form—

$$\lambda p'v' + A' + B'/\lambda v' + C'/\lambda^2 v'^2 + D'/\lambda^4 v'^4 + E'/\lambda^6 v'^6 + F'/\lambda^8 v'^8,$$

where λ equals T_2/p_2v_2 and p' and v' are the reduced pressures and volumes respectively. If the two following experimental conditions are fulfilled, viz., (1) that the difference in the kinetic energy of the gas before and after expansion is negligible, and (2) that the conduction of heat from the apparatus to the expanding gas is also negligible, then the expansion process will be represented by the equation : $\epsilon_1 + p_1v_1 = \epsilon_2 + p_2v_2$ (ϵ being the internal energy of the gas and the subscripts 1 and 2 referring to the initial and final states respectively) quite independently of whether the expansion has taken place through a valve or a plug or from a high or low initial pressure. The author deduces an equation for calculating the heat-effects, which he then calculates for hydrogen expanding against atmospheric pressure under various conditions of initial temperature and pressure. The results of the calculations, which are tabulated, confirm the expression obtained by van der Waals (Ibid. 2. p. 879, 1900,), viz.—

$$T_1 - T_2 = 2 \times 273\ [a\{2f(T_1) - T_1f'(T_1)\}/v_1 - RT_1b/(v_1 - b)]/mC_p,$$

and the conclusion that at a given value of T_1 we may give p_1 such a value that the cooling has a max. value ; they also show that as the initial pressure increases the cooling effect (if any) increases, reaches a maximum, diminishes, and finally, at high pressures (as long as t_2 is greater than 1), changes into a heating effect. The relation between inversion-temperature and pressure-difference is practically linear, and with increasing initial pressure the inversion temperature falls. The divergence between the author's and Olszewski's results leads to the conclusion that expansion through a reduction-valve of the construction used by Olszewski does not satisfy the conditions embodied in the equation $\epsilon_1 + p_1v_1 = \epsilon_2 + p_2v_2$ and in the equation employed for calculating the heat effects, which equations govern a process at the beginning and end of which the enthalpy (Gibbs's heat function $= \epsilon + pv$) has the same value. T. H. P.

1256. *Researches on the Joule-Kelvin Effect, especially at Low Temperatures. II. Joule-Kelvin Effect for Air at 0° and at Pressures up to 42 Atmospheres.* **J. P. Dalton.** (Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 874–888, May 24, 1909. Communication No. 109c from the Phys. Lab., Leiden.)—It is shown that special precautions are necessary before a reduction-valve apparatus, such as Olszewski [see preceding Abstract] used, will give a true Joule-Kelvin effect, and experiments are described dealing with the construction of such reduction-valve apparatus particularly adapted to a determination of Joule-Kelvin effects at low temperatures. The results obtained with this apparatus in the case of air at 0° are in good agreement with those calculated from the isothermals, and also with those experimentally determined by Joule and Kelvin. T. H. P.

REFERENCES.

1257. *Sensibility of the Clinical One-minute Maximum Thermometer.* **H. F. Wiebe.** (Zeitschr. Instrumentenk., Beib. 8. pp. 21–26, Feb. 1, 1909. Communication from the Physikal.-Techn. Reichsanstalt.)—An investigation carried out upon different forms of thermometer by various makers.

1258. *Thermal Conduction of Metals and Internal Radiation.* **M. Reinganum.** (Phys. Zeitschr. 10. pp. 355–359, May 15, 1909.)—Discusses mathematically the question as to whether internal radiation is concerned in the conduction of heat in metals. It is found that internal radiation fails utterly to explain the experimental value of thermal conductivity, and, as a correction, need not be taken into account. [See also Abstract No. 1207 (1908).] E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1259. *Partition of Energy in Electrical Systems.* **J. D. van der Waals, Jr.** (Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 580–590, Feb. 25, 1909.)—A criticism of the electromagnetic theories of Jeans [Abstract No. 1690 (1905)], Ritz, and Planck. Ritz does not appear to assume statistical equilibrium, and if the system considered is enclosed within walls of infinite thickness these must be considered as totally reflecting. Jeans' theory, though it accounts for observations with regard to specific heat, does not explain how a system could be heated by radiation. There is no sufficiently cogent reason for making us adopt Planck's conception of an atomic structure of energy. The author considers systems of electrons agreeing with those examined by Lorentz, enclosed in a rectangular space with totally reflecting walls. He gives a qualitative proof of the existence of electrons without mechanical mass, but it does not follow that no electrons possess mechanical mass. Further applications of the statistical method must be tested by deducing spectroscopic formulæ from them and finding whether they agree with the facts. E. E. F.

1260. *Principle of Relativity.* **D. Mirimanoff.** (Ann. d. Physik, 28. 1. pp. 192–198, Dec. 28, 1908.)—The differential equations of Lorentz's electrodynamics may be brought into agreement with the principle of relativity by slightly changing some of Minkowski's hypotheses and definitions. Thus it becomes necessary to reject a portion of Minkowski's first axiom and the first group of the transformation equations in the third axiom. The second axiom is retained. But all relations in which dielectric constant, the permeability, and the conductivity occur must be changed correspondingly. E. E. F.

1261. *Principle of Relativity.* **M. Born.** (Ann. d. Physik, 28. 3. pp. 571–584, March 2, 1909.)—Though the method of Abraham and Sommerfeld, which bases the dynamics of the rigid electron on the principles of ordinary mechanics, cannot be brought into agreement with the principle of relativity, it is still possible, on the basis of Minkowski's generalisation of Hamilton's principle [see Abstract No. 1990 (1908)], to establish a fundamental principle for the dynamics of moving charges which considers only electromagnetic quantities and not inert masses, and arrive at the well-known equations of motion of electricity. These appear then as the necessary conditions to be fulfilled if an integral related to Minkowski's potential integral is to have an extreme value under certain limiting conditions. The mass integral disappears and only reappears later in the form of a Lagrange multiplier. The new dynamical principle is closely related to the variation principle which forms the base of Maxwell's equations. Atomistic conceptions are not used, but may be introduced at any stage by dealing with cases where the distribution of electricity varies very rapidly within a small space. E. E. F.

1262. *Dissipation of Energy in an Electromagnetic Field.* **A. Comessatti.** (N. Cimento, 16. pp. 361–376, Nov.–Dec., 1908.)—The dissipation of energy in an electromagnetic field generated by a single charge has been investigated by Picciati [see Abstract No. 1996 (1904)]. By similar methods the author proves that in the case of two moving charges the dissipation is zero only if (*a*) both charges move with uniform velocity, or (*b*) the accelerations of the two charges are in opposite directions and are inversely proportional to the masses. E. E. F.

1263. *Pure Electromagnetic Fields.* **L. Caffaratti.** (N. Cimento, 16. pp. 376–380, Nov.–Dec., 1908.)—In a previous paper [Abstract No. 1488 (1908)] it was stated that an electromagnetic field cannot be maintained by pure rotation unless the speed of the charges attains the velocity of light. But a distinction must be made between a field occupied by charges and a field in which the density ρ is zero. The original demonstration applies with this restriction, that the case in which the space effectively occupied by charges is limited by a surface not uniformly convex remains doubtful.

E. E. F.

1264. *Motion of an Electron in a Combined Electric and Magnetic Field.* **W. B. Morton.** (Phys. Soc., Proc. 21. pp. 300–304, March, 1909.)—That the path of an electron in a combined electric and magnetic field is a cycloid may be proved in a purely geometrical way by a consideration of the velocity and acceleration of a point on a wheel which is rolling steadily along a straight line. The acceleration of such a point can be resolved into two components—one of constant magnitude and direction, perpendicular to the line along which the circle rolls, and the other perpendicular to the instantaneous direction of motion of the point and proportional to its velocity. These correspond to the accelerations given to an electron by the electric and magnetic fields respectively. If the point is on the circumference of the circle its velocity will vanish when it is the point of contact with the fixed line, so its initial circumstances coincide with those of the electron liberated at the plate. Therefore their paths are identical. By taking the tracing-point anywhere in the plane of the circle, we get the more general result that an electron projected in any manner in a plane perpendicular to the magnetic lines will describe a trochoid. E. E. F.

1265. *Electric Origin of Molecular Attraction.* **W. Sutherland.** (Phil. Mag. 17. pp. 657–670, May, 1909.)—Following the argument of previous papers, the author regards a molecule or atom as being a bipole having electric polarity of moment es, and represented as caused either by the separation of two electrons e of opposite sign through a distance s, or by considering the atom electrised, so as to have a total electric moment es. As each atom is thus equivalent to an infinitely short bipole of equal moment at its centre, the law becomes rigorous that one atom acts on another with a force inversely as the fourth power of the distance between their centres. But, if the relative directions of the two electric axes of two atoms are random, repulsion will occur as often as attraction. This is the great difficulty in accounting for cohesion by means of electric polarity, especially in the case of gases in which the kinetic theory has made random distribution the ideal of generality. It was pointed out in a former article that as the attractive forces tend to increase themselves, while the repulsive tend by their own action to diminish themselves, there must be a tendency, even in a random distribution of polarities, for the attractive forces to preponderate. But it is now suggested that the electrisation of neighbour molecules is not randomly directed, but so directly that an atom is attracted by each of its six nearest neighbours. This satisfies the main condition for minimum electric potential energy in a set of moving molecules whose axes of electrisation are free from constraint, except that of being translated with the molecule. Beyond the range of the six nearest neighbours the attractions and repulsions of a molecule tend to become more nearly equal and opposite, the greater the distance. Thus we have a range of force which is actually infinite, but is effectively an attraction reaching only the six nearest neighbours of a molecule. The effective range of molecular attraction is thus the distance between a molecule and its immediate neighbours. This principle is verified by the fact that dielectric capacity does not appear in values of cohesion. Although in a small group of molecules, say a molecule and its six nearest neighbours, there is at any instant a prevailing direction of electrisation, this varies with time, and at a given instant of time varies gradually from one group to the next, so that throughout a large number of molecules the directions of electrisation are as many as if distributed at random.

The subject is also treated quantitatively, and the work and formulæ of Fessenden and of J. E. Mills are discussed. E. H. B.

1266. *Theory of Electric Radiations.* **Levi-Civita.** (Accad. Lincei, Atti, 18. pp. 83–93, Feb. 7, 1909.)—In order to eliminate the linkage between the polar and equatorial diameters of the moving electron, postulated in the theories of Lorentz, Bucherer, and Poincaré, the author substitutes for an atomistic structure of electric rays an "asymptotic" fluidic structure, which enables him to treat the field as composed of threads or tubes of electric flux. He shows how such a theory, free from arbitrary assumptions, is capable of accounting for the principal properties of kathode rays and the β-rays of radium. E. E. F.

1267. *Motion of an Electron and Ion in a Magnetic Field.* **A. Righi.** (N. Cimento, 17. pp. 195–202, April, 1909.)—To understand the constitution of "magnetic rays" [see Abstract No. 674 (1909)] the movements of a positive ion and negative electron, rotating one around the other in a magnetic field, require to be known. The problem may be simplified by assuming (1) that, as the mass of the electron is very small compared with that of the ion, the latter is fixed, except for a translatory motion in common with the electron, and (2) that the electron moves in a plane perpendicular to the magnetic field, which may be taken as uniform and constant. Under these conditions, if r is the distance between the ion and electron, and x, y are the Cartesian co-ordinates of the electron at any instant t, $x \,.\, dy/dt - y \,.\, dx/dt = k/2 \,.\, r^2 + a$, where a is a constant. From this relation the author deduces that for any given position of the electron, its velocity is independent of the magnetic field, and if $x = r \cos \omega t$, $y = r \sin \omega t$, with r a constant, and $r\omega^2 = h/r^2 + kr\omega$, the trajectory is a circle, with the positive ion as centre. The velocity of the electron is then given by $v^2 = (dx/dt)^2 + (dy/dt)^2 = r^2\omega^2$. A system consisting of an ion and an electron is necessarily unstable, but its duration is prolonged by a magnetic field of suitable direction, and a lengthy explanation of the action of the latter is given. W. H. St.

1268. *Motion of Electrons in Solids.* Part I. **J. H. Jeans.** (Phil. Mag. 17. pp. 773–794, June, 1909.)—The author seeks in this paper to develop an electron theory of metals which shall be free from all suppositions for which there is not direct numerical justification. The conductor is assumed to contain N free electrons, each of mass m and charge e moving with the velocities assigned to them by Maxwell's law, which gives the partition of velocities for particles in collision or acted on by any field of force, as well as on a free path. It is assumed in the first place that the motion consists of free paths and collisions, and on this assumption the author establishes the equation—

$$d/dt\,.\,(\mathrm{N}mu_0)=\mathrm{NX}e-\mathrm{N}\gamma u_0, \qquad\qquad (8)$$

where X is the electric force parallel to the axis of x, u_0 the average velocity of an electron parallel to X, and γ is a quantity depending only on the sum of the squares of the velocities and on constants, subject to the condition that the interval of time dt is large compared with the time of collision. It is then shown that, provided the quantities do not change too rapidly with the time, the same equation, with a suitable value of γ, will express the relation between X and u_0, whatever be the nature of the motion of the electrons. Ohm's law for steady currents then follows immediately, and, on calculating the rate at which energy is dissipated by the resistance, it is found that the conductivity κ for steady currents and the conductivity c for currents of frequency p are connected by the relation—

$$\mathrm{C}=\kappa/(1+\kappa^2p^2m^2/\mathrm{N}^2e^4) \qquad\qquad (10)$$

The relation obtained, by a different method, by J. J. Thomson leads to the somewhat different expression—

$$\mathrm{C}=\kappa(1-\tfrac{1}{2}\kappa^2p^2m^2/\mathrm{N}^2e^4+\ldots).$$

The difference is attributed by the author to the fact that Thomson's system is, so to speak, kinematical and not dynamical. In a dynamical system the time of a free-path must depend on the velocity with which the path is described. The fundamental equation is then shown to lead to equations for the propagation of light identical with those of Drude, although reached in a different manner. The restrictions under which the fundamental equation was established limit their validity to light of period much greater than the time of a collision. The velocity of an electron being about 10^{-7}, and the radius of an atom about 10^{-8} cm., the time of collision will probably be about 10^{-15} sec. In light of wave-length $\lambda=4\mu$, the period would be about thirteen times the time of collision, and the author considers this to be the lowest periodicity for which the formulæ are applicable. Rubens and Hagen [see Abstracts Nos. 62, 64 (1904)] write—

$$\mathrm{C}_\lambda=(100-\mathrm{R})\sqrt{\kappa},\quad \mathrm{C}'_\lambda=36{\cdot}5/\sqrt{\lambda},$$

where R is the reflecting power for wave-length λ, and κ is the conductivity for infinite wave-length. We should have $\mathrm{C}_\lambda=\mathrm{C}'_\lambda$ if the variation of conductivity were negligible. According to the equations of this paper—

$$\mathrm{C}'_\lambda=(100-\mathrm{R})\sqrt{c},$$

and—

$$(\mathrm{C}_\lambda/\mathrm{C}'_\lambda)^2=\kappa/c=1+\kappa^2p^2m^2/\mathrm{N}^2e^4-\mathrm{S},$$

where S is a term required by resonance, and is introduced in this way by Schuster [see Abstract No. 1114 (1904)]. The necessity for this term is shown by some of Rubens and Hagen's results making C^λ less than C'_λ, and it can be shown from the principle of conservation of energy to be necessarily positive, and therefore if S be neglected the equation will give an upper limit for N when the ratio C_λ/C_λ' is known. Except in the case of steel, there seems to be no substance for which the upper limit for N is not greater than the upper limit already set by the specific heat of the substance. As far as the calculations determine an upper limit for N, the values are in general agreement with the law of Schuster, derived by the application of Drude's equations to visible light, according to which, if n is the number of atoms per unit volume, $N = pn$, where p is a number lying between 1 and 3. The exception in the case of steel is taken by the author as probably indicating that the assumption that the magnetic permeability may be taken as unity for the periodicity considered is not allowable in this case. Assuming, as the author does, that the electrons have energy appropriate to the temperature, Dulong and Petit's law sets the upper limit of 2·2 for all metals, and a still lower limit for some. Radiation across the interface between air and a metal is then considered, and it is shown that if V_1 and V_2 are the velocities in the two media, and if the energies per unit volume of radiation of frequency between p and $p + dp$ are E_1dp and E_2dp, then the interchanges of energy will be equal provided—

$$E_1V_1^3 = E_2V_2^3, \quad \text{.........................}(24)$$

a known thermodynamic result here established from purely electrodynamic principles. The energy in a cavity in a body of any kind being of the form—

$$E_1 = f(T, p), \quad \text{.........................}(25)$$

it follows that the energy in the interior of the body itself must be of the form—

$$E_2 = (V_1/V_2)^3 f(T, p), \quad \text{.........................}(26)$$

so that the partition of energy inside matter can be determined in terms of black-body radiation. As a consequence of this it is shown that if A is the coefficient of absorption for light incident on the body, the stream of issuing radiation is $\frac{1}{4}Af(T,p)dp$, that is to say, it is A times the stream issuing from a black body, in accordance with Kirchhoff's law. This law being thus derived as a consequence of purely electron theory, independently of whether the ether is in equilibrium with matter or not, and independently of thermodynamic considerations of any kind, it is illegitimate to draw any thermodynamical inferences from the observed truth of this law. The emission in time t from a volume dv, on the hypothesis that t can be divided into n equal free-path periods each of time τ, is then shown to be—

$$\left(\int \frac{8\mu}{\pi V} \frac{\sin^2 \frac{1}{2}p\tau}{\tau} \frac{Ne^2}{m} RT dp\right) t dv, \quad \text{.........................}(33)$$

which vanishes when τ is either very great or very small, so that when the motion is regarded as made up of free-paths, the whole phenomenon of emission depends on the free-path being finite. Let the energy in the steady state be $\int E_p \,.\, dp$, then equating the above expression to the absorption as found by J. J. Thomson [see Abstract No. 1545 (1907)], viz.—

$$\left(\int \frac{4\pi C^2}{K} c E_p dp\right) t dv, \quad \text{.........................}(34)$$

where C is the constant of radiation, we have—

$$E_p = p^2 RTK\mu/\pi^2 C^3 V = p^2 RT/\pi^2 V^3. \quad \text{..................}(35)$$

This last equation is then shown to hold independently of the assumption of free-paths. E_p depends on the structure of the medium only through the factor $1/V_1^3$, which accords with the observed fact that the radiation in a cavity is independent of the nature of the matter, and therefore, from (25), (26), and (35), the radiation in the cavity in which the velocity is V_1 will be given by—

$$E_p = p^2RT/\pi^2V_1^3. \quad \dots\dots\dots\dots\dots\dots(42)$$

Now $p\lambda = 2\pi V$ in metal, and $2\pi V_1$ in cavity, so that, both in metal and in air,

$$\int E_p dp = \int 8\pi RT\lambda^{-4}d\lambda,$$

showing equipartition of energy, in each case, between the different vibrations of great wave-length. T has been introduced as defined by the mean kinetic energy of the free electrons in the interior of a solid, and, being identical with the mean energy of vibrations of great wave-length in the interior, either may be taken to define the temperature of the solid, which is identified with these values by experimental evidence [see Abstracts Nos. 870 (1901) and 1825 (1908)]. Since the specific heat of all metals is approximately 5·88, corresponding to an energy per atom of 3RT, and this is also the energy corresponding to two free electrons, it would appear to follow that the energy of translation and rotation of the atoms must be insignificant, and therefore not governed by the temperature (otherwise each would contribute energy 3RT, making 9RT in all). The motion of the atomic framework arising from collisions with electrons may therefore be regarded as dissipated into radiation so rapidly that the atoms never acquire a motion comparable with temperature-motions. Of the two electrons thus assumed to every atom, some only may be free in bad conductors at low temperatures. This would give 5·88 as the maximum atomic heat only when these electrons have all become free—a result in accordance with Weber's experiments (Ann. Phys. u. Chemie, 154. p. 575). Near the point of fusion, the atomic energy will greatly increase, explaining Pionchon's value of 9·84 for the atomic heat of iron at 500° C. The author suggests that conduction between a solid and a gas would be explained if molecules of the solid formed large clusters taking up the temperature from the electrons and conveying it to the gas. This would only increase the specific heat imperceptibly, the energy of each cluster being 3RT or 6RT, instead of that of each atom. The temperature of a solid might then be defined by the mean kinetic energy of its molecular clusters. G. W. DE T.

1269. *Insulators in a Rotating Electrostatic Field.* **A. Lampa.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 1045–1053, July, 1908.)—In a previous paper [Abstract No. 1055 (1907)] the author showed that a non-conducting insulator rotates in a rotating electric field, provided it has viscous dielectric hysteresis. v. Schweidler [Abstract No. 650 (1908)] has since pointed out that Pellat's theory of dielectric after-effect offers the best guidance for the treatment of anomalous dielectric effects. The author therefore investigates dielectric hysteresis from the point of view of this theory. He finds that it accounts qualitatively for the phenomena. For quantitative agreement an extension of the theory is necessary. And even this does not explain why the moments are proportional to E^n, where E is the amplitude of the field intensity and $n = 1·5$ to $1·96$. The amplified theory makes $n = 2$.

E. E. F.

1270. *A Method of Determining the Atomic Charge of Electricity.* **F. Ehrenhaft.** (Phys. Zeitschr. 10. pp. 808–810, May 1, 1909. From Akad. Wiss. Wien, Sitz. Ber. Ser. 2a. 1909.)—It is found that minute particles of silver, zinc, &c., when suspended in the air are effected by an electric field. This indicates the existence of very large ions, of mass 10^{-13}, some of which carry a positive charge, others a negative charge. The mean velocity in an electric field is found to be the same for both kinds of ions. Their magnitude is determined by the rate at which they fall under the action of gravity, the assumption being made that Stokes' formula holds good in this case; it is also found by direct microscopic observation. The mean value of the radius of the silver particles is found by the first method to be $8{\cdot}1 \times 10^{-6}$ cm., and by the second $8{\cdot}8 \times 10^{-6}$ cm. The rate of motion of these ions in an electric field is used to determine their charge, which is found to be identical with the atomic charge, $e = 4{\cdot}46 \times 10^{-10}$, $e = 4{\cdot}51 \times 10^{-10}$, and $e = 4{\cdot}68 \times 10^{-10}$ electrostatic unit being the result of three determinations. A. E. G.

1271. *Electric Potential of the Atmosphere on Mount Etna.* **C. Bellia.** (N. Cimento, 17. pp. 174–178, March, 1909.)—A comparison of atmospheric potential during the latter part of last August, at Catania, 45 m. above sea-level, and at stations on the side of Mount Etna, respectively 1,882 and 2,942 m. above sea-level, shows that the fall of potential is in all cases positive, and increases rapidly with the altitude. The diurnal variation is different in the three stations, there being a double oscillation at Catania, with maxima at 10h. and 20h. and minima at 4h. and 16h., whereas at the two higher points there is only a single oscillation, with a maximum during the day and a minimum during the night. At all three stations the curve of vapour tension closely resembles that of the atmospheric potential. The electric dispersion at the intermediate height is normal, but that at the Mount Etna observatory is anomalous, the dispersion of negative electricity being almost equal to that of positive electricity. W. H. Sr.

DISCHARGE AND OSCILLATIONS.

1272. *Diffusion of Gaseous Ions.* **E. M. Wellisch.** (Cambridge Phil. Soc., Proc. 15. pp. 1–10, Feb. 23, 1909.)—The mobility, or velocity in a given field, of an ion may be expressed in terms of its mass, charge, mean free path, and mean speed of thermal agitation. Its coefficient of diffusion D, may also be expressed as one-third of the product of the last two quantities [see Langevin, Abstract No. 1412 (1908)]. But these quantities cannot be directly determined by experiment. The author deduces the following equations, which are not open to that objection:—

$$k = \frac{A\eta}{\rho_1 p}\left\{1 - \frac{(K_1 - 1)\pi A^2\eta^2}{2p_1^2\rho_1}\right\}^{-1}, \quad D = \frac{\eta}{\rho}\left\{1 + \frac{(K_1 - 1)\pi A^2\eta^2}{2p_1^2\rho_1}\right\}^{-1},$$

where η is the viscosity, ρ the density of the gas, K the dielectric constant, p the pressure, and A the aggregate of ionic charges per cm. The suffixes denote the same quantities at standard temperature and pressure. These formulæ show a fair agreement with experimental values for the singular substances, but in ammonia, ethyl alcohol, and ethyl chloride the observed mobilities are two or three times too high. These vapours also show a marked deviation from Maxwell's law $K = n^2$. E. E. F.

1273. *Mobilities of Ions produced by Röntgen Rays in Gases and Vapours.* **E. M. Wellisch.** (Roy. Soc., Phil. Trans. Ser. A. 209. pp. 249–279, May 4, 1909. Proc., Ser. A. 82. pp. 165-166, May 6, 1909. Abstract.)—For a constant pressure the velocity of the ions, both positive and negative, varies as the electric intensity. In general the mobility k (velocity under unit electric intensity) varies inversely as the pressure; in N_2O and CO_2 pk slightly increases as p falls below 7 cm. Hg; in ethyl chloride pk fell off markedly as the vapour approached the saturated state (this probably applies to all vapours). In vapours little difference in general between mobilities of positive and negative ions; mobility of positive ion greater in aldehyde, ethyl alcohol, acetone, SO_2, ethyl chloride, pentane, ethyl acetate, methyl bromide, and ethyl iodide. There is no direct relation between mobilities and molecular weights. Smaller mobilities belong to gases with high critical temperatures (= vapours), greater mobilities to gases with low critical temperatures. The mobility of the ion is calculated from the kinetic theory of gases. Experimental results can be explained approximately on the supposition that the ion consists of a single molecule with which is associated a charge equal to that carried by the monovalent ion in electrolysis. A. D.

1274. *A Direct Method of proving the Charge of α-Rays.* **H. Greinacher.** (Deutsch. Phys. Gesell., Verh. 11. 7. pp. 179–184, April 15, 1909. Physikal. Inst. d. Univ., Zürich, Feb., 1909.)—The presence of the δ-rays forms a difficulty in proving the charge of the α-rays. A simple method for carrying out the experiment is described, which is similar in principle to that used by P. and S. Curie for investigating the negative charge on the β-rays. The principle of the method is that the α-particles are allowed to impinge upon a receiving plate which is very carefully insulated. Polonium preparation is used as the source of the rays. Shellac is used as the insulating medium, and it is found to acquire no especial conductivity under the action of the α-rays. The experiments confirm the result that the α-particles lose their electric charge as well as their power of ionising, at the end of their course. A. E. G.

1275. *Charge on Negative Ion of a Flame.* **G. Moreau.** (Comptes Rendus, 148. pp. 1255–1257, May 10, 1909.)—The author finds from nine experiments values for the negative ionic charge varying from 4·1 to 4·8, each multiplied by 10^{-10}, giving the mean value $e = 4{\cdot}8 \times 10^{-10}$ electrostatic unit. The values found by Millikan, by Perrin, and by Rutherford are characterised by the numbers 4·06, 4·1, and 4·65 respectively. [See also Abstract No. 676 (1909).] E. H. B.

1276. *Thermionics.* **O. W. Richardson.** (Phil. Mag. 17. pp. 813–883, June, 1909.)—To that branch of physics dealing with the "emission of ions by hot bodies," the "leak from hot wires," &c., the author gives the name *thermionics*, the ions emitted by the hot body being termed *thermions*. The author discusses mathematically various problems in thermionics. If in a region of space otherwise vacuous there are a number of hot surfaces A emitting ions and a number of conducting surfaces B, in general there will be an electric field in the region under consideration, so that any or all of the surfaces may be charged. The ions emitted by the surfaces A will move under the combined influence of their initial velocity and that of the electric field, and will ultimately reach one of the surfaces A or B or go off to an infinite distance. If the temperatures of the surfaces A are maintained constant, the number and mode of distribution of velocity of the ions they emit will remain constant, and if in addition the potentials of the various surfaces are maintained constant, it is clear that, whatever may happen at first, a steady state will ultimately be established in which the number and mode of distribution of velocity among the ions received by any of the surfaces in a given time will be invariable. The problem considered is to find the number of ions which reach any of the surfaces B in a given time, together with their velocity components, when the steady state has been established. It is assumed that the motion of the ions is determined solely by their positional and velocity co-ordinates when they are emitted and by the electric field, the forces exerted in the ions by each other and by molecules of gas into whose sphere of action they may chance to penetrate being left out of account. These conditions are capable of being realised in practice with close approximation if thermionic currents of moderate size are experimented with in high vacua. It is further supposed that the temperature conditions are such that ions of only one sign occur. The mathematical treatment considers (1) general discussion in rectangular co-ordinates; (2) initial boundary conditions; (3) the case of no electric forces; the cases of A and B being (4) parallel and (5) inclined planes; (6) the case of a cylinder A surrounded by two concentric solid cylinders; and (7) the case of a thin hot wire. For details of the mathematical treatment the original must be consulted.

T. H. P.

1277. *Spontaneous Conductivity of Dark Sodium Vapour and the Relation between Ionisation of the Gases and the Absorption of their Line Spectra.* **C. Füchtbauer.** (Phys. Zeitschr. 10. pp. 374–377, June 1, 1909. Theoret.-physikal. Inst., Leipzig, May 8, 1909.)—In this preliminary communication a detailed account and diagram of the apparatus is given, with particulars as to the method of carrying out the research. At 210° C. a marked conductivity due to Na vapour is observed. A curve is given for 288·8°, in which the current is plotted against the voltage. This shows that with 2–6 volts the conductivity of the vapour obeys Ohm's law; a very flat part of the curve occurs between 16 and 24 volts, and after this a rapid continuous increase of current, which goes on up to the highest voltage used, viz., 72 volts. By extrapolation it is found that above 880° the conductivity can be measured by means of a galvanometer. The absorption of the Na lines has also been observed at 190°, and the conductivity due to Na was perceptible also in this case at 199°. The author concludes that Na and the other alkali metals are ionised when in the condition of vapour.

A. E. G.

1278. *Kathode Volatilisation in Rarefied Gases.* V. **V. Kohlschütter.** (Zeitschr. Elektrochem. 15. pp. 316–328, May 15, 1909.)—The author continues his experiment [see Abstract No. 582 (1909)] with constant currents produced by a Toepler influence machine, with 20 rotating discs, modified to give somewhat stronger currents of up to 1 milliamp. at 100 revs. The kathode potentials are measured by means of Braun electrometers. The wire kathode is in the centre of a spherical glass bulb and an exploring electrode close to it. The anode, mounted in a lateral pocket, does not project into the sphere proper. The electrodes Au, Ag, Pt, Pd, Cu, Ni, are worked for 80 min. in the gases argon, nitrogen, hydrogen, when the loss in weight is determined; the gas pressure diminishes by a few hundredths of a mm., and the potential rises as the discharge goes on. The general results previously obtained by Holborn and Austin and by the author and Goldschmidt are confirmed. The volatilisation is proportional to the current intensity and increases with increasing potential in argon and nitrogen; in hydrogen a maximum volatilisation is soon reached. The weights of metals volatilised at the same current intensity vary as the equivalents, but different valencies of the metals have to be assumed for the discharges in argon and nitrogen; in argon the metals appear to have the valencies one or two. Peculiarities are noticed in the behaviour of Pt and also of other metals. The volatilisation decreased throughout in the order argon, nitrogen, hydrogen. The statement of Fischer and Hähnel that the volatilisation would, under equal conditions, become the same in argon and in hydrogen, is not confirmed. H. B.

1279. *Kathodic Projections.* **L. Houllevigue.** (Comptes Rendus, 148. pp. 1320–1322, May 17, 1909.)—It is known that a kathode in a vacuum projects, not only corpuscles deviable by a magnet, but also parts of its proper substance. These projections of matter are not deviable to an appreciable extent by a magnetic field. This shows that the projected particles have either (1) a large mass, (2) a feeble charge, or (3) a high velocity. The experiments here given favour the first hypothesis while not excluding either of the other two. E. H. B.

1280. *Theory of Discontinuous Discharge in Geissler Tubes.* **H. A. Perkins.** (Comptes Rendus, 148. pp. 1389–1391, May 24, 1909.)—The phenomena described in a previous paper [see Abstract No. 1087 (1909)] are readily explained by a knowledge of the capacity of Geissler tubes. If E is the e.m.f. of the terminals, R the external resistance of the circuit, r the resistance in the tube circuit, I the current in the principal circuit, i_c the current which charges the capacity, i_r the current through the resistance r, C the capacity of the tube, V the p.d. between the electrodes, ε the minimum p.d. for a discharge to take place in the tube, the author derives the following equations:—

$$\mathrm{V}=\frac{1}{c}\int i_c dt=\frac{1}{c}\int(\mathrm{I}-i_r)\,dt=\frac{1}{c}\int\left\{\mathrm{I}-\left(\frac{\mathrm{V}-\varepsilon}{r}\right)\right\}dt;$$

$$\mathrm{I}=e^{-\left(\frac{r+\mathrm{R}}{\mathrm{RC}r}\right)t}\left\{\frac{\mathrm{E}r+\mathrm{R}\varepsilon}{\mathrm{R}(r+\mathrm{R})}-\frac{\mathrm{V}_1}{\mathrm{R}}\right\}+\frac{\mathrm{E}-\varepsilon}{\mathrm{R}+r},$$

where V_1 is the p.d. at the commencement of the charge; and—

$$\mathrm{T}=\frac{\mathrm{RC}r}{\mathrm{R}+r}\log\frac{r\mathrm{E}+\mathrm{R}\varepsilon-\mathrm{V}_1(r+\mathrm{R})}{r\mathrm{E}+\mathrm{R}\varepsilon-\mathrm{V}_0(r+\mathrm{R})},$$

for charging the capacity from V_1 to V_0. From the last equation it follows that as E increases T diminishes, and tends towards zero as the fraction approaches unity. [See also Abstract No. 685 (1909).] W. H. Sr.

1281. *Striated Discharge.* **J. J. Thomson.** (Cambridge Phil. Soc., Proc. 15. p. 70, Feb. 23, 1909.)—A Wehnelt hot lime kathode was used to produce the discharge, as it was found that at low pressures the striations produced in this way were remarkably steady and bright, and therefore made accurate measurements of the distribution of electric force much easier than with the ordinary discharge. It was found that just in front of the bright surface of a striation towards the kathode there was a reversal of the electric force. This reversal causes a great accumulation of ions in the part of the striation nearest the kathode. The recombination of the ions in this region is therefore much greater than elsewhere. A very simple explanation of the formation and behaviour of striations is given by the hypothesis that the luminosity is caused by the recombination of the ions in the striations.

E. E. F.

1282. *Some Vacuum-tube Phenomena.* **A. A. Campbell Swinton.** (Röntgen Soc., Journ. 5. pp. 59–62; Discussion, pp. 62–66, May, 1909.)—The arrangement for converting a diamond into coke is described [see Abstract No. 988 (1908)]. For this purpose a vacuum tube with two concave kathodes which focus upon the diamond is used. Under the diamond is an iridium plate which in turn is supported in a Pt cap. To convert a diamond as large as a pea about half a kilowatt of energy is required (10,000 volts, 50 milliamps). The diamond does not apparently contain one or more of the rare gases of the argon group [see Roy. Soc., Proc. Ser. A. 82. p. 176, May 6, 1909], as Crookes and Parsons thought, since no change is found in the spectrum of the residual gas when observed before and after the conversion of the diamond into coke. The temperature at the time of the diamond's change is estimated to be 1,890° C. The manufacture of rubies is also described.

A. E. G.

1283. *Increased Anode-fall due to Electro-negative Gases.* (D.R.-P. 207,854. Elektrotechnik u. Maschinenbau, 27. p. 505, May 23, 1909. Abstract.)—O. Huldschinsky states that by introducing the smallest quantity of iodine into a vacuum tube the anode-fall is increased twenty-fold. He suggests that a suitable discharge tube with high anode-fall can be used as a rectifier for high-tension alternating currents.

A. E. G.

1284. *Discharge of Condensers.* **E. Caudrelier.** (Comptes Rendus, 148. pp. 1257–1259, May 10, 1909.)—Describes experiments on discharges through a spark-gap on which a current of air is directed. From the results it is concluded that the form of the spark may be attributed to the ionisation of the air in the gap.

E. H. B.

1285. *Dispersion of Damped Waves.* **N. N. Andreev [Andrejev].** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 41. No. 1. pp. 46–55, 1909.)—It has been shown by Kolli [Abstracts Nos. 959 (1908), 121, 122 (1909)] that the refractive index within absorption bands depends not only on the period of vibration, but also on the coefficient of damping of the incident waves. The author attempts to bring this phenomenon into accord with the theory of dispersion. Assuming that the damping of the waves is very much smaller than that of the electron vibrations, he arrives at the following fundamental formula for the dispersion of damped waves :—

$$n^2(K_0^2 + 1 - KK_0 - iK^2)^2/(K_0 + 1)^2 = 1 + \Sigma(N_h e_h^2/m_h)/\pi$$
$$[(1 + k_h^2)/T_h^2 - 1/T^2 + 2k_h i/TT_h],$$

when n is the refractive index, K the absorption index of the body, K_0 the coefficient of damping of the outside waves and T their period, letters with the subscript h representing the corresponding magnitudes for the electrons. The consequences of this formula are partly in agreement with experimental data. For further testing the theory, the author proposes the formulæ;

$nK = (K_0^2 + 1)(nK)_0$ and $n = n_0 + K_0(nK)_0/(K_0^2 + 1)$, where n_0 represents the refractive index and $(nK)_0$ the index of absorption of the body for undamped waves. From these expressions further equations are deduced, but they cannot be tested owing to the lack of determinations of K_0 and nK. T. H. P.

1286. *Diffraction of Damped Electric Waves.* **O. Bartenstein.** (Ann. d. Physik, 29. 2. pp. 201–248, May 21, 1909. Physikal. Inst., Jena, March, 1909.)—The apparatus here used was in the main like that of Lebedew for the electro-optic phenomena. Diffraction effects were thus easily observed and were found to be different from those predicted by the ordinary theory for light. The discrepancy was attributed to the damping of the electric waves. The theory for such damped waves was then developed and gave a good agreement with the experiments. E. H. B.

1287. *Field of an Electric Oscillator of any Form.* **A. Montel.** (Lumière Électr. 6. pp. 199–208, May 15, and pp. 237–241, May 22, 1909.)—By means of certain assumptions the author obtains a mean current or system of currents in the dielectric, which is the resultant of or equivalent to the dielectric currents, and determines the amplitude, phase and position of these currents. From these resultant dielectric currents and the oscillator current he determines the field at a distant point. He first considers the open oscillator of Hertz and then a closed rectangular oscillator. In this latter case he finds the vertical field at a point P in the equatorial plane given by—

$$Z = \frac{Ean^2}{vr}\left\{[1 - \cos(mb\cos\phi)]\sin\Omega - \sin(mb\cos\phi)\cos\Omega\right\}$$

In this formula E = amplitude of charge, a and b = length of sides of rectangle, $n = 2\pi/T$, $m = 2\pi/\lambda$, v = velocity of light, r = distance of P, ϕ = azimuthal angle, $\Omega = mr = nt$. This equation gives results accordant with experience. The second paper is a continuation of a previous one on horizontal antennæ in wireless telegraphy [see Abstract No. 1182B (1908)]. When the horizontal part of Marconi's sender is bent towards the ground, Fleming found a considerable diminution in the laterally radiated energy. The author modifies his formula to suit this case and works out results which agree with Fleming's experimental results. He then does the same for Schmidt's oscillator, in which the vertical sender has its bottom end stretched parallel to the surface of the earth. T. P. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1288. *Heat Transformations in Selenium.* **A. Pochettino.** (Accad. Lincei, Atti, 18. pp. 449–455, May 2, 1909.)—From measurements of the difference in temperature between the selenium and the sand-bath in which it was heated, the author concludes that the temperature of the first transformation of vitreous Se into dark-grey crystalline Se is indefinite, rising with the rate of heating, and ranging in these experiments, from 101° when heated at a rate of 0·5–1° per min. to 175° for a rate of 18–22° per min. The second change- or melting-point, is independent of the rate of heating, taking place at about 204–206°. The fused mass on cooling evolves heat at 123–125° but is then still pasty, and no definite solidifying point can be fixed. Examination of a thin, transparent layer of Se, when heated, under a microscope, confirms the preceding results, the layer becoming opaque above 100°. The electrical resistance of a thin layer of amorphus Se, which at ordinary temperatures, and up to 100° remains practically infinite, diminishes very rapidly between 110° and 125°, and then more slowly up to 145°, when it becomes almost constant till 178° is reached, above which it gradually fades away again up to 201°. These last results support Lehmann's hypothesis of two crystalline forms of Se of different electrical conductivity, the first a good conductor, formed at the first transformation, and the second a poor conductor, at about 200°. W. H. Sᴛ.

1289. *Electrical and Optical Properties of Selenium.* **A. H. Pfund.** (Phys. Zeitschr. 10. pp. 340–346, May 15, 1909. Johns Hopkins Univ., March, 1909. Translation.)—After describing the method of constructing a reliable selenium cell, the results are given in tables and curves for the variation, with the wave-length of the incident light, of the conductivity, reflecting power and absorbing power of such cells, the region investigated being that between 450 and 1,000 $\mu\mu$. There is a distinct maximum of conductivity for light of wave-length 700 $\mu\mu$, and when the intensity of the incident light is increased this maximum shifts towards the region of short wave-lengths. Further, the absorption curve shows that the incident energy is absorbed for the most part in a layer the thickness of which is of the same order of magnitude as that of the critical layer for which the specific resistance of the material changes. [See Abstract No. 368 (1904).] G. E. A.

1290. *Pirani's Method of Measuring Self-inductance.* **E. C. Snow.** (Phil. Mag. 17. pp. 849–854, June, 1909.)—In Pirani's method of measuring the self-inductance of a coil it is assumed that the self-inductance of the galvanometer used can be neglected. Silva [see Abstract No. 470 (1907)] has proved that this assumption is legitimate when the discharge of the condenser is non-oscillatory. The author investigates the case when the discharge is oscillatory. He obtains the exact formula for the current i through the galvanometer, and he shows that if $\int_0^{\infty} i\,\partial t = 0$ be true when there is no deflection the method is correct. He points out, however, that a galvanometer is an imperfect instrument for indicating whether the integral sum of the transient currents through it is zero or not and refers to papers by Rayleigh and Russell on the subject [see Abstract No. 1910 (1906)]. A. R.

1291. *Measurement of Inductances with Oscillatory Currents.* **C. J. Watson.** (Electrician, 62. pp. 809–810, March 5, 1909.)—The author describes a simple method of measuring inductances which has the advantage of requiring no special apparatus. It is a bridge method analogous to that mentioned by Prasch (Samml. Elektrot. Vorträge, 8. p. 90, 1906), two inductances being balanced against two capacities and a vacuum tube being used as indicator. The bridge is fed at two opposite points, from a coil, through two Leyden jars in the usual way. The jars may be of about 0·002 mfd. each; their outsides are connected by a single layer of No. 36 wire wound on a tube ½ in. diam. and about 4 in. long. Together with the spark-gap such a circuit has a frequency of about 1 million. The bridge condensers should be of equal capacity, and may be glass plates coated with tin-foil, of about 700 m.mfd. each. The unknown inductance is put in one, and a pair of Lecher wires in the other arm of the bridge, and the movable slider is then adjusted until the tube is extinguished (middle of a space of a few cm.). The inductance of the Lecher wires being readily calculable the unknown inductance is determined. If a number of calibrated variable inductances are prepared these can be substituted for the Lecher wires. Certain precautions to be observed are described. L. H. W.

1292. *Standardisation of Condensers.* **Devaux-Charbonnel.** (Comptes Rendus, 148. pp. 1512–1514, June 7, 1909.)—Gives the results of a number of measurements of the capacity of a mica condenser. The mean of 6 values at a frequency of 100 shows the accuracy to be well within 1 part in 1,000. At a frequency of 500 the capacity was determined to be about 7 in 10,000 less than at the former frequency. Under the same conditions the capacity of an air condenser was found to be invariable. F. E. S.

1293. *Peculiar Form of Electrical Conductivity of Solid Substances.* **K. Bädeker.** (Ann. d. Physik, 29. 3. pp. 566–584, June 10, 1909. Physikal. Inst. d. Univ., Jena.)—Cuprous iodide, silver iodide, and certain other substances take up small proportions of iodine, which causes them to become electrical conductors. This action, which is especially great with cuprous iodide, may be varied considerably by altering the iodine concentration. The conduction effected in this manner is metallic in character; the action of temperature on it was determined, and in some cases the Hall-effect, which has opposite sign to that observed with bismuth. The action of a magnetic field on the specific resistance is small, being less than 0·1 per cent. per 1,000 gauss. Observations were made of a peculiar kind of thermoelectric force between cuprous iodide layers of varying iodine-content and the magnitudes of the thermoelectric forces between such layers and metals. T. H. P.

1294. *Residual Charges in Dielectrics.* **C. L. B. Shuddemagen.** (Amer. Acad., Proc. 44. No. 18. pp. 467–521, May, 1909. Contribution from the Jefferson Phys. Lab., Harvard Univ.)—The author describes a method of studying the rate of formation of residual charge during very short charging intervals. When the interval is small the "absorption current" is far from negligible, and the residual charge which it forms within 0·0017 sec. after charging begins is generally of the order of several per cent. of the "free charge." Glass and paraffined paper condensers show the greatest residual charge formation for short charging times, but it is smaller in mica condensers. The latter condensers exhibit an absorption current which decreases but slowly with the time, so that for long-continued charging they may take up much more residual charge than the paraffined paper condensers, whose absorption current is very large at first, but decreases rapidly as the time increases. The glass condenser shows both a high residual forming current immediately after the beginning of the charge and a rather slow decrease as the time increases. As to the cause of residual charge the results of the work cannot give much information. It seems likely, however, that air-bubbles in the dielectric medium play a very important part. F. E. S.

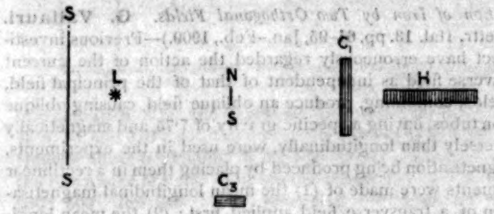
1295. *Crystal Rectifiers.* **G. W. Pierce.** (Amer. Acad., Proc. 44. No. 12. pp. 317–349, March, 1909. Contribution from the Jefferson Phys. Lab., Harvard Univ. Phys. Rev. 28. pp. 153–187, March, 1909.)—An exhaustive investigation which is extended to include the following crystals: Carborundum, anatase, brookite, and molybdenite [see Abstract No. 1575 (1907)]. Oscillograms are reproduced showing the rectified cycle with the different rectifiers. No lag of the rectified cycle with respect to the voltage-phase cycle is found; the rectified cycles, in fact, lead their respective voltage-phase cycles —at three positions in the case of molybdenite, but only in one position in the case of carborundum. No evidence of a thermoelectric or other integrative action of the rectifier has been detected in the photographs. Experiments carried out to test the thermoelectric hypothesis of the origin of the effect, show that with a rise of temperature produced in a thermo-couple placed at the point of contact of the copper and molybdenite 1,100 times as great as the rise indicated during rectification, the thermal current in the copper-molybdenite circuit is only $\frac{1}{500}$ of the rectified current; the thermoelectric current is, moreover, generally opposite in sign to the rectified current. L. H. W.

1296. *Theory of Wehnelt Interrupter.* **P. Ludewig.** (Ann. d. Physik, 28. 1. pp. 175–191, Dec. 28, 1908. Elektrotechn. Inst., Karlsruhe, Aug., 1908.)—There is no discontinuity in the frequency of the Wehnelt interrupter as the length of the anode is increased. No distinction of two essentially different types of action can be made. Under all circumstances the bubble which interrupts the current consists of both electrolytic oxygen and thermal water-vapour. In the Wehnelt interrupter, as distinguished from Simon's perforation type, a bubble of gas which partially covers the anode begins to form while the current is rising. The fact that, as the rate of interruption increases, an ever smaller quantity of gas suffices to bring about the interruptions is due to the fact that the oxygen ascends in the course of its formation, and also that part of the gas active in one interruption is used in the next one. In the perforation interrupters, on the other hand, the bubble is formed suddenly at the end of the current-rise. [See Abstract No. 679 (1908).] E. E. F.

1297. *Induction Coil giving a 50-inch Spark.* **C. B. Hayward.** (Scientific American, 100. pp. 260–261, April 3, 1909.)—Although the coil described is said to differ totally in design and construction from the ordinary coil, practically the only innovation consists in the omission of the paraffin insulation in the sections. The primary coil is 6 ft. long, 4 in. in diameter, and weighs 210 lbs. The primary consists of two layers (748 turns) of No. 6 (B. & S. gauge) double cotton-covered wire (resistance 6·2 ohms, weight 1 cwt.). The primary and core are enclosed in a micanite tube 10 ft. long, 8 in. external diameter, and having walls 1¼ in. thick. The secondary is made up of 284 sections, each $\frac{3}{16}$ in. thick, of No. 32 double cotton-covered wire (961 turns per coil). Each coil is insulated from the next by a $\frac{1}{32}$-in. micanite plate, extending 1 in. beyond the windings. The total wire on the secondary weighs 213 lbs., and has a resistance at 68° F. of 118,428 ohms. The coil takes 25 amps. at 110 volts when giving a 50-in. spark. The interrupter is of the rotating commutator type, having 20 rings, all connected in series: the break takes place at the same instant throughout the series. At 1,000 r.p.m. of the driving motor, 2,000 impulses are thus produced in the coil, the duration of the interruption corresponding to 1/39424 sec.; the duration of break as compared with that of make is as 1 : 2,240. Illustrations are given. L. H. W.

1298. *Powerful Laboratory Electromagnets.* **G. Zindel.** (Elektrotechn. Zeitschr. 30. pp. 446–449, May 13, 1909.)—An electromagnet for obtaining very high magnetic intensities for physical research, designed by P. Weiss, is described and illustrated. The magnetising coils, which consist of spirals of copper strip insulated and placed side by side, embrace the cylindrical pole-pieces, which are movable along their common axis by screwed nuts provided with hand-wheels. The coils are enclosed in sheet-iron cylindrical cases containing paraffin oil, which is cooled by means of a water-coil, so that the temperature of the magnet and coils can be maintained constant at 20° C. Each coil consists of 1,600 turns, enabling a magnetomotive force of 200,000 amp.-turns to be given to the magnet, and gaining thereby a field intensity between the pole-forces of 46,000 gauss, *i.e.*, 10 per cent. higher than that hitherto obtained. In order to obtain maximum field intensity with a minimum of amp.-turns, the pole-tips are shaped off towards their end-faces so that the flux density is kept approximately equal at all sections. The field intensity of these magnets was measured by the electromagnetic balance of Cotton, in which the strength of a field is determined from the force it exerts on a small element of current. The article concludes with a description of this balance. J. D. C.

1299. *Improved Magnetometer.* **J. G. Gray and A. D. Ross.** (Roy. Soc. Edinburgh, Proc. 29. pp. 182–192, 1908–1909.)—Describes an improved form of magnetometer and accessories for the testing of magnetic materials at different temperatures. The ordinary form of magnetometer has many disadvantages, and so an attempt was made to design a new form. In planning the apparatus the following requirements were kept in view: (1) the magnetometer must be capable of accurate and rapid adjustment; (2) there must be no resultant Erhard effect; (3) the instrument must be suited for testing specimens at all temperatures from that of liquid hydrogen to the critical temperature; (4) it must be alike efficient for testing strongly magnetic and feebly magnetic specimens; (5) the magnetising solenoid must be capable of furnishing fields up to at least 400 c.g.s. units; (6) the instrument must be rigid, all parts fitted on one bed plate, and the coils must be capable of being clamped without danger of destroying the compensation. The general principle of the instrument is shown in the Fig. NS is the magnetometer needle provided with a concave mirror, by means of which and a source of light L its movements are observed on the scale SS. H is the magnetising solenoid, C_1 C_2 are compensating coils, C_3 giving a fine adjustment. If the axes of C_1, H, and C_2 are not coincident, as is usually the case, an adjustment of the current in C_3 and of its position will give perfect compensation for all positions of NS. The magnetising solenoid is water-cooled, the wire being wound on the outer of two brass cylinders, 4 cm. and 6 cm. diam. For high temperatures an electric furnace of a type similar to that devised by G. E. Allan is placed within the helix, and the temperature is measured by means of a thermo-element or a Pt-resistance thermometer. For photographs and constructional details see original paper. A. W.



1300. *Apparatus for recording the Emanation from the Ground.* **H. Ebert.** (Phys. Zeitschr. 10. pp. 346–350, May 15, 1909. Physikal. Inst. d. techn.

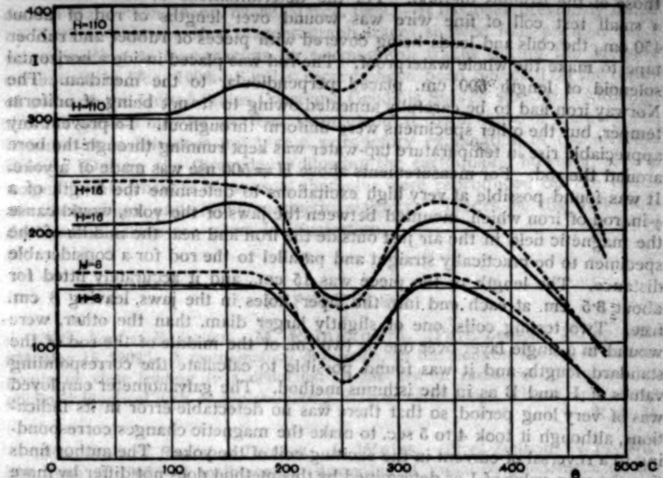
Hochschule, München, Feb., 1909.)—Describes and discusses an instrument capable of making a continuous record of the emanation from the ground. Within a cylindrical hole in the ground two concentric cylinders hang, the outer one connected to a high-voltage battery and the inner one to a quadrant electrometer of special construction, by means of which the ionisation discharge between the two cylinders is recorded (photographically). A simultaneous record of the daily variation of emanation, atmospheric pressure and temperature is given. G. E. A.

1301. *Marine Collimating Compass.* **W. J. Peters.** (Terrestrial Magnetism, 14. pp. 17–24, March, 1909. Paper read before the Amer. Assoc. for Advancement of Science, Dec. 31, 1908.)—The author was in command of the magnetic survey yacht *Galilee* during its cruise in the Pacific, 1906–1908, and made numerous comparisons of the accuracy attainable with various types of instrument. With the Ritchie 8-in. liquid compass, using either the cylindrical mirror or the dark plane mirror, it was found that readings may be in error by as much as half a degree. One difficulty is that the two readings are not made simultaneously, and in consequence of the continual yawing of the ship the card moves appreciably after the azimuth is taken. To obviate the difficulties a collimating compass was designed and constructed. The instrument is described, with illustrations of the various parts separated. C. P. B.

ALTERNATING CURRENTS AND MAGNETISM.

1302. *Magnetisation of Iron by Two Orthogonal Fields.* **G. Vallauri.** (Atti dell' Assoc. Elettr. Ital. 13. pp. 61–95, Jan.–Feb., 1909.)—Previous investigators of the subject have erroneously regarded the action of the current producing the transverse field as independent of that of the principal field, whereas the two fields, combining, produce an oblique field, causing oblique magnetisation. Iron tubes, having a specific gravity of 7·75, and magnetically much harder transversely than longitudinally, were used in the experiments, the longitudinal magnetisation being produced by placing them in a rectilinear solenoid. Measurements were made of (1) the mean longitudinal magnetisation under the action of a transverse field applied first; (2) the mean longitudinal magnetisation under the action of a transverse field applied after the iron had been first subjected to a longitudinal field; (3) the mean transverse magnetisation under the action of a longitudinal field applied first; and (4) the mean transverse magnetisation under the action of a longitudinal field applied after a transverse field had been first applied. Full tables with curves are given of the results obtained. Hysteresis in a rotating field and in an alternating field was also measured, and it is concluded that in an anisotropic medium the greatness of the alternating hysteresis is, for equal maximum magnetisation, independent of its direction. The existence of an *angle of return*, described by Villari, is confirmed, and is readily explained by hysteresis. W. H. St.

1303. *Magnetic Properties of Certain Copper Alloys.* **A. D. Ross** and **R. C. Gray.** (Roy. Soc. Edinburgh, Proc. 29. pp. 274–286, 1908–1909.)—The specimens consisted chiefly of Heusler bronzes containing varying proportions of Mn and Al. These were tested at ordinary temperature and at —190° C. after various treatments. It was found that these bronzes exhibit less hysteresis, but are also less magnetic, after quenching. Such alloys, if rich in copper, are more magnetic at —190° than at 15°. Continued baking at steady temperatures reduces the susceptibility and increases the hysteresis towards definite limits. These effects are not simply related to the temperature of baking. The effect of three hours' baking on a specimen of the ordinary Heusler alloy is exhibited in the curves given, in which abscissae represent the temperature of baking and ordinates the intensity of magnetisation, after the specimen has cooled to room temperature, in fields of 8, 16, and 110 c.g.s., the dotted lines showing the effect of liquid air. In Heusler alloys containing 76, 62, and 55 per cent. of copper respectively, and the remainder Mn and Al in atomic proportions, the critical temperatures are 280°, 500°, and 345°. The quenching and liquid air effects in the Heusler alloys are very similar to those in Cu_3Al modified by effects due to the presence of free Cu and free Mn. G. E. A.



1304. *Effect of Cyclic Temperature Change on Magnetic Moment.* **J. G. Gray** and **H. Higgins.** (Roy. Soc. Edinburgh, Proc. 29. pp. 287-294, 1908-1909.)—Bars of various kinds of steel, including manganese and chromium steels, are magnetised at liquid-air temperature and are then tested by magnetometer first at that temperature, then after the specimen has warmed to the temperature of the room, again at —190°, and so on. The results obtained differ from those observed by Dewar and Fleming in that the reversible condition is arrived at after the first warming up to room temperature, and the percentage change in magnetic moment then brought about by cooling from room temperature to that of liquid air is much greater than is the case for a specimen which has been magnetised initially at room temperature. Diagrams are given showing the successive magnetic conditions arrived at by the cyclic temperature treatment. G. E. A.

1305. *Permeabilities and Reluctivities of Normal Specimens of Compressed Steel, Bessemer Steel, and Norway Iron Rods.* **B. O. Peirce.** (Amer.

Journ. Sci. 27. pp. 278–288, April, 1909.)—The paper consists of a description of a long series of determinations of normal brands of compressed steel, Bessemer steel, and Norway iron in the form of ¼-in. rods over a wide range of excitation, and it considers especially a method of measurement in a massive yoke in the region H = 400 to H = 2,500, which lies above the limits of most permeameter observations and below those of the isthmus method. For the determinations at low excitations a small test coil of fine wire was wound over lengths of rod of about 450 cm., the coils and leads being covered with pieces of rubber and rubber tape to make the whole waterproof. The rod was placed inside a horizontal solenoid of length 500 cm. placed perpendicular to the meridian. The Norway iron had to be carefully annealed owing to its not being of uniform temper, but the other specimens were uniform throughout. To prevent any appreciable rise in temperature tap-water was kept running through the bore around the rod. For measurements above H = 500 use was made of a yoke. It was found possible at very high excitations to determine the length of a ¼-in. rod of iron which, mounted between the jaws of the yoke, would cause the magnetic field in the air just outside the iron and near the middle of the specimen to be practically straight and parallel to the rod for a considerable distance. The length of the piece was 15 cm., and it accurately fitted for about 8·5 cm. at each end into the taper holes in the jaws, leaving 8 cm. free. Two testing coils, one of slightly larger diam. than the other, were wound in a single layer over one or two cm. of the middle of the rod of the standard length, and it was found possible to calculate the corresponding values of H and B as in the isthmus method. The galvanometer employed was of very long period, so that there was no detectable error in its indications, although it took 4 to 5 sec. to make the magnetic changes corresponding to a reversal of current in the exciting coil of the yoke. The author finds that the max. value of I as determined by this method does not differ by more than 1 per cent. from that given by the isthmus method. He considers his yoke method is more satisfactory, since a series of determinations of I_∞ by the method do not vary over as much as 1 per cent. of the mean, whereas he finds that the isthmus method does not give trustworthy results in the case of hard steel. The paper concludes with a number of curves and tables of results. [See also Abstract No. 903 (1909).] W. C. S. P.

1306. *Haupt Magnetometer.* **H. Jordan.** (Deutsch. Phys. Gesell., Verh. 11. 9, pp. 215–230, May 15, 1909. Communication from the Kaiserl. Telegraphenversuchsamt.)—Describes methods of investigating the magnetic properties of iron, &c., by means of Haupt's astatic magnetometer. A general theory is first developed for ellipsoidal bodies and then the results of experiments on straight bars and ellipsoidal laminæ and solids are given. The magnet system of the magnetometer consists of two cylindrical steel magnets 15 cm. long and 0·2 cm. thick; these are connected in the middle by an Al rod 7 cm. long and at the ends by semicircular strips, the system being then suspended so as to hang vertically and rotate about its axis of symmetry. A helical spring connected to the upper semicircular strip and to a torsion head gives the necessary control and serves to measure the couple acting on the magnets. The coil for magnetising the specimens dealt with (30 cm. long, 281 turns per cm., 0·4 cm. diam.) is placed so that its axis is perpendicular to the plane of the magnets and passes through the middle point of the line joining the upper magnetic poles. A compensation coil is placed in a corresponding position with respect to the lower poles. The magnet system is always brought back by means of the torsion head until its plane is perpendicular to the coils, so that the amount of torsion measures the component of the magnetic field parallel to the length of the specimen. Curves are given showing the results obtained with the apparatus. A. W.

1307. *Peculiar Magnetic Disturbances, Dec.,* 1908. **D. L. Hazard.** (Terrestrial Magnetism, 14. pp. 37–38, March, 1909.)—It has been previously noted by C. Chree that the Kew magnetograph traces showed four peculiar burrs corresponding to four maxima on seismograph traces during the Messina earthquake in Dec., 1908. Similar records have been detected on the traces of some of the United States Coast and Geodetic Survey stations. Although these in general may be ascribed to mechanical disturbance of the magnets, in some cases this does not give a satisfactory explanation of the changes shown. During the three days following the earthquake, however, several magnetic disturbances of unusual character were reproduced on the traces at Cheltenham and other magnetic stations. Traces of the H.F. and declination curves are given in illustration. C. P. B.

REFERENCES.

1308. *Law of Radiation.* **M. Reinganum.** (Phys. Zeitschr. 10. pp. 351–355, May 15, 1909.)—A mathematical discussion, on the electron theory, of various points of view leading to a deduction of the law of radiation. Formulæ are obtained identical with or approximating to those of Rayleigh, Planck, and others. E. H. B.

1309. *Planck's Radiation Theorem.* **J. Weiss.** (Phys. Zeitschr. 10. pp. 387–390, June 1, 1909.)—A mathematical discussion of radiation phenomena on the electron theory with special reference to the views and formulæ of Planck and Jeans. [See Abstract No. 910 (1909).] E. H. B.

1310. *Positive Electrons.* **A. Dufour.** (Journ. de Physique, 8. pp. 411–422, June, 1909. Paper read before the Soc. française de Physique, Feb. 5, 1909.)—Discusses the probability of certain phenomena observed by J. Becquerel being due to free positive electrons, which view is here discredited. [See Abstract No. 1463 (1908).] E. H. B.

1311. *Ions of the Atmosphere.* **J. A. Pollock.** (Science, 29. pp. 919–928, June 11, 1909. Presidential address to Australian Assoc. for Advancement of Science.)—*Résumé* of the subject (including Wellisch and Sutherland's observations) particularly in relation to atmospheric electricity. A. D.

1312. *Hertzian Waves and Fredholm's Equation.* **H. Poincaré.** (Comptes Rendus, 148. pp. 1488–1490, June 7, 1909.)—The author continues his investigations [see Abstract No. 691 (1909)] on the electric actions that take place in a conductor when subjected to Hertzian waves. A method of simplifying the equations is explained. A. R.

1313. *Thermo-Endosmose.* **Aubert.** (Comptes Rendus, 148. pp. 1254–1255, May 10, 1909.)—A short note on experiments following up the method of Lippmann. [See Abstract No. 1720 (1907).] E. H. B.

1314. *Recording Compass.* **Heit.** (Comptes Rendus, 148. pp. 1386–1389, May 24, 1909.)—A description of a somewhat complicated electrical arrangement by means of which the direction of a ship's compass is registered automatically at intervals of one minute. A. W.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1315. *Apparatus for the Purification of Gaseous Hydrogen by means of Liquid Hydrogen.* **H. Kamerlingh Onnes.** (Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 883–886, May 24, 1909.)—The continuous action of the liquid hydrogen cycle [see Abstract No. 81 (1907)] is only possible when a sufficient quantity of extremely pure hydrogen is available. The author has devised an apparatus for the purification of hydrogen by freezing out the impurities of the gaseous hydrogen by means of the pure liquid hydrogen of the cycle. For details the original must be consulted. T. H. P.

1316. *Atomic Weights.* **A. C. G. Egerton.** (Chem. Soc., Journ. 95. pp. 238–242, Feb., 1909.)—The atomic weights of the first fifteen elements, when expressed with reference to hydrogen as a unit, differ slightly from whole numbers. When expressed with reference to oxygen as 16, they are almost exactly whole numbers, except hydrogen, which becomes 1·0078. The number 0·0078, by which the atomic weight of hydrogen ($O = 16$) differs from unity, may be regarded as the aggregate atomic weight of eight electrons, and the weights of the first fifteen elements may be derived from hydrogen by taking the nearest whole number and adding or subtracting a constantly increasing number of times this factor. The formula for the atomic weight is $A \pm B$ (0·0078). B assumes the following values, all of which are negative except in the case of glucinum (beryllium), magnesium, and silicon: He 4, Li 6, Gl 8, boron 10, C 12, N 13, O 16, F 18, Ne 20, Na 22, Mg 24, Al 26, Si 28, P 30. B equals either A or $A - 1$. The above relation may be put as follows:—

The atom of	helium	is	4	atoms of	hydrogen,	less	2	groups of	16	electrons.
„	lithium	is	7	„	„	„	3	„	16	„
„	glucinum	is	9	„	„	plus	4	„	16	„
„	boron	is	11	„	„	less	5	„	16	„
„	carbon	is	12	„	„	„	6	„	16	„
„	nitrogen	is	14	„	„	„	13	„	8	„
„	oxygen	is	16	„	„	„	8	„	16	„
„	fluorine	is	19	„	„	„	9	„	16	„

and so on. In the higher elements, groups of electrons have to be both added and subtracted in order to obtain the correct atomic weights.

E. E. F.

1317. *Composition of Air.* **G. Claude.** (Comptes Rendus, 148. pp. 1454–1456, June 1, 1909.)—Prolonged study of the working of the apparatus previously described [Abstract No. 149 (1909)] shows that by its means the proportions in air of gases less condensable than air may be determined with greater accuracy than they have been measured up to the present time. The mixture of neon and helium obtained had the density 0·53–0·57 (air = 1), the ratio of the amount of neon to that of helium in the air having the mean value 412 : 143. One million parts of air contain 15 of neon, 5 of helium, and less than 1 of hydrogen. T. H. P.

1318. *Decomposition of Water by the Salts of Radium.* **A. Debierne.** (Comptes Rendus, 148. pp. 703–705, March 15, 1909.)—Referring to Ramsay's note on the decomposition of water by the action of radium salts [Abstract No. 158 (1909)], in which the observation is recorded that a solution containing a relatively considerable quantity of radium bromide ceased to disengage the mixture of hydrogen and oxygen, though the same solution had given previously for a long time a regular disengagement of the gases, the author states that though he has frequently observed the decomposition of water in a solution of a radium salt he has never noticed an anomaly like that described by Ramsay. Ramsay supposes the cessation of the appearance of the gases may be due to a spontaneous change in the properties of radium. The author considers this improbable, but suggests the phenomenon may be accounted for by the appearance of secondary products. There is an excess of hydrogen present in the gases liberated, and this shows that part of the oxygen has been absorbed by the solution, and that oxides have been formed which may accumulate in the solution, provoke the absorption of hydrogen at the instant of its formation, and thus cause a diminution of the amount of gas liberated. The author regards the decomposition of water in a solution of a radium salt as probably due chiefly to the direct action of the rays emitted, α, β, or γ. Contrary to the experience of Ramsay, he has succeeded in proving the decomposition of water without contact between the water and the salt or the emanation, simply by the action of the penetrating β- and γ-rays. The salt was separated from the water, in the experiments made, by the glass of a vessel which contained the radium salt, and the α-rays were absorbed by the glass. One experiment lasted many months, and a slight progressive diminution of the amount of gas produced was noticed towards the end of the period. The mean rate of production of the gas was 0·115 c.cm. per day per gm. of radium. It would appear that 1 per cent. of the total energy is absorbed by the water and transformed into chemical energy. J. J. S.

1319. *Chemical Action on Water of the Penetrating Rays from Radium.* **M. Kernbaum.** (Comptes Rendus, 148. pp. 705–706, March 15, 1909.)—Referring to Debierne's experiments [see preceding Abstract], the author has carried out tests with the object of finding whether in the decomposition of water by rays from radium the proportion of hydrogen to oxygen is normal or whether there is an excess of hydrogen, as found by Ramsay in repeated experiments. The experiments were carried out in Mme. Curie's laboratory, and the radium salt employed was 100 mgm. of almost pure radium chloride, which was enclosed in a thin glass bulb. The rays passed through this glass, through a few mm. of air, and through the thin glass wall of the vessel containing the distilled water, which was boiled and carefully freed from air. The gas obtained was tested by means of a eudiometer experiment, and it was found that the penetrating rays from radium in acting on distilled water across glass set free hydrogen, and at the same time produce oxygenated water. The gas collected at the end of the experiment was chiefly hydrogen. Further experiments are in progress. J. J. S.

1320. *Does Thorium exist as Thorium Silicate in Monazite?* **O. Kress** and **F. J. Metzger.** (Amer. Chem. Soc., Journ. 31. pp. 640–652, June, 1909. Contribution from the Havemeyer Lab. of Columbia Univ., No. 165.)—Chemical and microscopic examination of a number of monazites show that thorium is not present in these minerals in the form of thorium silicate.

T. H. P.

1321. *Electric Smelting.* **F. W. Harbord.** (Elect. Engin. 43. pp. 634–637; Discussion, p. 637, May 7, 1909. Paper read before the West of Scotland Iron and Steel Inst., Glasgow, April 16, 1909.)—The power consumption of the different types of furnaces for the production of steel from cold scrap and pig is about the same, and ranges from 750 to 1,000 kw.-hours per ton; refractories will cost 8s. 6d. or more, and about 35 lbs. of electrodes will be consumed per ton in Héroult and Girod furnaces and 22 lbs. in Stassano furnaces. The Kjellin furnace is recommended for dealing with pure materials; ordinary scrap requires an extremely basic and yet fluid slag, and in that case the other furnaces mentioned and the Roechling-Rodenhauser furnaces are suitable. Under British conditions electric furnaces can only answer for smelting cold materials when pure, and for refining Bessemer or open-hearth steel. In the latter process 300 kw.-hours, for some purposes only 120 or 150 kw.-hours, will be required per ton, and with electric energy at ¼d. per unit, the cost for obtaining an exceptionally pure product should remain under 1 guinea per ton, and be justifiable. Rail steel is made in Roechling-Rodenhauser and other furnaces. The Héroult and Girod types have the advantage of easy repair; Stassano avoids contact between electrodes and metal. The direct smelting of iron ores has little importance from the British standpoint, but conditions are different elsewhere, and the treatment of magnetite and of titaniferous iron sands is promising. Vat-shaped (Keller) furnaces are difficult to charge, and the electrodes must be protected from the gases. The Gröndal furnaces and the Lash process deserve attention. High-grade ferro-silicon and ferro-chrome, as well as ferro-manganese (Gin) can only be made in electric furnaces; Giffre furnaces yield a low-carbon ferro-chrome (5 per cent. of C or less) valuable for tool-steel manufacture. Very little has been done in Britain, but the absence of water power is not a serious disadvantage; gas-engines, especially where blast-furnace gas is available, should be able to compete in the ferro-silicon industry, for instance. At present the author advocates the electric furnace only as an adjunct in Britain. H. B.

1322. *Influence of Silicon on Iron.* **E. Kolben.** (Schweiz. Elektrot. Zeit. 6. pp. 201–204, April 24; 213–215, May 1; 225–227, May 8; 237–238, May 15, and pp. 249–250, May 22, 1909. Engineering, 87. pp. 732–733, May 28, 1909. Abstract.)—Data are quoted given by F. G. Wick [Abstracts Nos. 275, 1478, 1670 (1908)] upon thermoelectric properties, Hall-effect, and electrical resistance in silicon. The following table resumes the principal results given by the author for iron-silicon alloys:—

Silicon, per cent.	0·02	1·07	2·28	3·25	3·5
Tensile strength, kg./mm.^{2}	30·8	35·1	47·3	—	61
Elongation, per cent.	11	7·5	6	—	3·5
Electrical resistance, ohms (1 m. long × 1 mm.^{2} section)	0·118	0·287	0·355	0·50	0·595
Increase of resistance per 100° C., rise of temperature, per cent.	41	19	14	7·5	5
„ (coefficient of hysteresis)	0·0015	0·0014	0·0010	0·0009	0·0009
Hysteresis, watts per kg.	2·5	2·2	1·65	1·45	1·45
Eddy currents, watts per kg.	1·3	0·8	0·7	0·6	0·4
Total losses, watts per kg.	3·8	3	2·35	2·05	1·85
B for H = 140	17,600	17,300	17,000	16,700	16,400

The value of the index of B is about 1·4 for high Si percentages and 1·8 for low percentages. Hence Si reduces the hysteresis. Further, as the addition of Si increases the resistance it decreases the eddy-current losses. The high

Si alloys are too brittle for use in dynamos, but can be employed in transformers. No ageing effect was found in the 3 per cent. Si alloys. The high-Si alloys are difficult to work, but if 0·6 per cent. of Mn be present they are more easily rolled. The author has patented the use of iron with from 2 to 6 per cent. Si and 0 to 5 per cent. Al for rheostats. Strips are stamped from sheet, dished, and strung on rods. **F. R.**

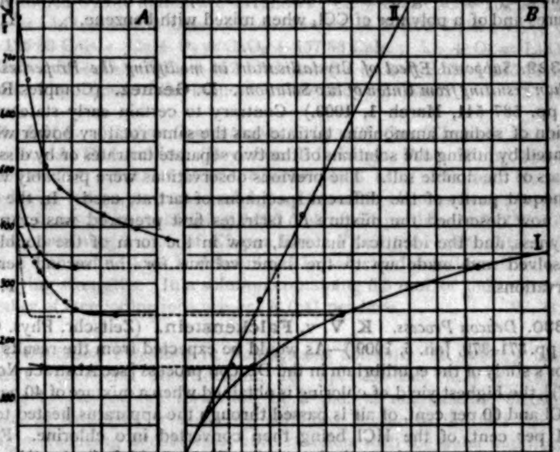
1323. *On the Sub-oxides of Cæsium.* **E. Rengade.** (Comptes Rendus, 148. pp. 1199–1202, May 3, 1909.)—Contains results of the examination of the system cæsium-cæsium protoxide by Tammann's method. The pure metal is contained in a vacuum vessel, and, after the addition of measured quantities of pure oxygen gas, cooling curves are obtained by means of an iron-constantan couple. In order to prevent the volatilisation of cæsium above 50° an atmosphere of nitrogen is used. The diagram obtained shows the existence of four definite combinations containing less oxygen than the protoxide. The first, Cs_7O, freezes at 3°, giving a maximum on the curve, the three others form at three transition-points, Cs_4O at 10°, Cs_7O_2 at 50°, and Cs_3O at 170°. Two eutectics are found, one at —2°, corresponding to $Cs—Cs_7O$, and the other at —8°, corresponding to $Cs_7O—Cs_4O$; this latter is only found on cooling slowly through several hours. If cooled more quickly an unstable eutectic is formed at —12°, corresponding to $Cs_7O—Cs_7O_2$; this, however, slowly changes into $Cs_7O—Cs_4O$. It is possible to isolate crystals of Cs_7O_2, which appear as long striated prisms, reddish-brown in colour and similar to crystals of permanganate of potash. It should be noted that the four sub-oxides given above possess formulæ incompatible with monovalence, which is generally considered to be a characteristic of the alkaline metals. C. O. B.

1324. *Influence of Small Quantities of Arsenic and Antimony on Copper.* **A. H. Hiorns** and **S. Lamb.** (Soc. Chem. Ind., Journ. 28. pp. 451–455; Discussion, pp. 455–457, May 15, 1909. Paper read before the Birmingham Section, March 11, 1909.)—It is well known that arsenic improves copper for many purposes, but there is considerable divergence of opinion as to the limits of arsenic content. The authors describe in detail the methods of preparation, treatment, and chemical analysis of alloys containing up to 3 per cent. As in one series and 3·5 per cent. Sb in the other. All the alloys were examined for hardness, rolling, and wire-drawing properties, electrical conductivity, and microstructure. *Copper and Arsenic.*—Arsenic increases the tendency of copper to give sound chill castings; the alloys rapidly lighten in colour and become appreciably harder as the As-content increases. Up to 0·5 per cent. As the alloys stand cold rolling and wire-drawing well. Between 0·5 and 2 per cent. As there is a tendency to crack, while above 2 per cent. the alloys again roll and draw well. The electrical conductivity is rapidly decreased by the addition of As. The microstructure shows dark-coloured polygons surrounded by a lighter coloured hard material rich in As. Slow cooling increases the size of the grains and promotes the separation of a blue structureless constituent (probably Cu_3As) from the lighter coloured body. *Copper-Antimony Alloys.*—Unlike As, Sb does not confer soundness on the chill castings. The presence of Sb slowly increases the hardness of copper and rapidly decreases the electrical conductivity. The microstructure is quite similar to that of the As alloys, Cu_3Sb being deposited between the grains on very slow cooling. In the *discussion*, **Turner** pointed out that the presence of small quantities of As increases the tensile strength of wrought copper, especially at high temperatures. **O. F. Hudson** considered that the apparent duplex nature of the alloys is misleading, the microstructures really representing "cores" in solid solutions. **D. M. Levy** discussed the effect of oxygen in the presence of As, and stated that the effect of As is enhanced by the simultaneous presence of lead. Replying, **A. H. Hiorns** confirmed the existence of the compound Cu_3As, to the presence of which he ascribed the deleterious influence of As on Cu. The authors' experiments have shown that this compound separates on slowly cooling alloys containing more than 0·2 per cent. As, and lead to the conclusion that it is not safe to introduce more than 0·2 per cent. of As into copper. The arsenical alloys are the most valuable of the copper alloys for resisting high temperatures. **S. Lamb** dealt with the methods of estimating As. F. C. A. H. L.

1325. *Heats of Combustion of Aluminium, Calcium, and Magnesium.* **F. E. Weston** and **H. R. Ellis.** (Faraday Soc., Trans. 4. pp. 166–169; Discussion, pp. 169–171, April, 1909.)—Preliminary experiments on the action of Al powder upon Al_2O_3, MgO, and CaO, respectively, in which air was not excluded, led to the conclusion that the heat of combustion of Mg is greater than that of Ca, since MgO is not reduced by Al, whilst CaO is reduced by Al at very high temperatures. The difference is not great, however, since it is possible to cause Ca to interact with MgO. The heats of combustion of Mg and Ca are much higher than that of Al. In the *discussion*, **H. K. Picard** said he had found similar results. He suggested that a reaction between alumina and aluminium sulphide might be a possible method of manufacturing Al. The **Authors** pointed out that nitrides formed in the reactions could not have been magnesium nitride, and **Weston** admitted a source of error common to all the experiments, as pointed out by **N. T. N. Wilsmore,** viz., the heat-changes due to formation of low oxides. F. R.

1326. *Effects of Calcium Aluminates on Mortars.* **H. S. Spackman.** (Frank. Inst., Journ. 167. pp. 186–204, March, 1909.)—Mixtures of sand, clay, and lime, without binding properties, are found to develop hydraulic and cementing qualities by the addition of calcium aluminate. Practically any desired setting time can be secured by proportioning the amount of the accelerator, and by the use of a retarder such as calcium sulphate. The early strength of such mixtures can be made greater than the early strength of Portland cement. Valuable wall-plaster compositions are given by adding small quantities of calcium aluminate to hydrated lime. Good results were given by the use of the accelerator with trass-lime compositions, and the early strength, hardness, and resistance to abrasion of natural cement is also greatly improved by the same means. Tests were made with aluminates prepared from bauxite, kaolin, high alumina slags, &c., all of which worked satisfactorily even in the presence of excess of silica or iron. Series of test results are given, and although cement with aluminate additions is not yet being made commercially, it is specially pointed out that in particular we now have the following possibilities: (1) A hard wall-plaster without the objections attaching to compositions at present in use; (2) aluminated lime mortars which will be able to compete with cement mortars for work which is not below water; (3) improvement of natural cements, or mixtures of lime and puzzuolana by addition of aluminate, with high early strength, and ultimately as strong as Portland cement. F. R.

1327. *On the Free Pressure in Osmosis.* **L. Vegard.** (Cambridge Phil. Soc., Proc. 15. pp. 18–23, Feb. 23, 1909.)—Measurements of the velocity of flow of solvent through a membrane showed a linear relationship between hydrostatic pressure and velocity of flow (Fig. *B* II), corresponding with a constant "specific resistance" for the system. This constant was nearly the same for two membranes differing widely in electrical resistance ; probably the latter depends on the presence or absence of a few minute pores through the membrane, which do not greatly affect the flow of liquid. When the flow is a result of osmosis and not of hydrostatic pressure the velocity for a given membrane is at first abnormally rapid, especially if the membrane is dry, but in most cases a steady condition is reached within about 2 hours (Fig. *A*). The curve connecting osmotic pressure with velocity of flow (Fig. *B* I) is quite distinct from the linear curve of flow under hydrostatic pressure, but *appears to be tangential to it at the origin.* From this it follows that for small velocities the whole energy of the system is made available for the motion through the membrane, the work required for motion under osmosis being just the same as the work required for *pressing* the pure solvent through with equal velocity. The author, adopting a view of osmosis that is very mechanical in character, deduces from this the conclusion that osmosis consists for the most part of a flow of pure water through the membrane under the influence of a gradient of hydrostatic pressure. But as this gradient causes a flow of solvent inwards through the membrane, it must be opposite in direction to the ultimate change from low pressure outside to high pressure inside which is the leading characteristic of osmosis. It is therefore necessary to assume a rapid *decrease* of hydrostatic pressure on passing from the solvent inwards into the membrane, followed by a sudden increase of pressure where the solvent in the membrane first comes into contact with the solution inside. This sudden increase of pressure he calls the "free pressure" of osmosis. When



the velocity of flow is small the hydrostatic gradient disappears and the free pressure becomes equal to the osmotic pressure, but during the earlier stages, when solvent is passing rapidly through the membrane, it is necessary to distinguish between the energy used in overcoming friction and that used in building up the osmotic pressure inside. The author's theory gives no explanation of the manner in which semi-permeability is brought about, but merely records the fact that the effect of the membrane is equivalent to a very great resistance against the flow of solution in bulk, whatever the manner in which this resistance is brought about. T. M. L.

1328. *Theory of Binary Mixtures and Concentrated Solutions.* **F. Dolezalek.** (Zeitschr. Phys. Chem. 64. 6. pp. 727–747, Nov. 24, 1908. Physikal. Inst. d. techn. Hochschule, Charlottenburg.)—The assumption is made that in an ideal mixture the partial pressure of each constituent should be proportional to its molecular concentration in the particular mixture under consideration, the total pressure would then be the sum of two *linear* partial pressures, and would itself be represented by a straight line. Exceptions (constituting 90 per cent. of the 160 cases that have been studied) are attributed to (1) dissociation of complex molecules and (2) formation of compounds. According to the laws of mass-action, each of these should be determined by a single constant, and a good agreement between observation and calculation is found by assuming the formation of a compound in acetone-chloroform mixtures and of a polymer of CCl_4 when mixed with benzene. T. M. L.

1329. *Supposed Effect of Crystallisation in modifying the Properties of the Solution resulting from Union of two Solutions.* **D. Gernez.** (Comptes Rendus, 148. pp. 587–541, March 1, 1909.)—Contrary to certain early statements, a solution of sodium ammonium tartrate has the same rotatory power whether prepared by mixing the solutions of the two separate tartrates or by dissolving crystals of the double salt. The previous observations were probably vitiated by unequal purity of the different specimens of tartrate used. In the operations now described the mixture of tartrates first prepared was evaporated to dryness, and the identical material, now in the form of the double salt, redissolved and made up to the same volume for the second series of observations. T. M. L.

1330. *Deacon Process.* **K. V. v. Falckenstein.** (Zeitschr. Phys. Chem. 65. 3. pp. 371–379, Jan. 5, 1909.)—As would be expected from the results of the author's study of the equilibrium in the Deacon process [see Abstract No. 1426 (1907)], the highest yield of chlorine is obtained when a mixture of 40 per cent. of HCl and 60 per cent. of air is passed through the apparatus heated to 430°, 70–71 per cent. of the HCl being then converted into chlorine. Further experiments show, as theoretical considerations would indicate, that, when the issuing gas is passed first through sulphuric acid to free it from water and then through a second Deacon apparatus at 430°, the yield of Cl reaches 82·5–85 per cent.; repetition of this process causes further increase to 87–89 per cent. T. H. P.

1331. *Osmotic Pressure of Cane-sugar Solutions at 20°.* **H. N. Morse and W. W. Holland.** (Amer. Chem. Journ. 41. pp. 257–276, April, 1909.)—The ratio of osmotic pressure to gas pressure was found to be 1·064 at 15° and at 25° [Abstracts Nos. 2048 (1908), and 989 (1909)]. The ratio now found for 20° is slightly higher at 1·069, but the difference is probably due to the fact that the sample of "candy-sugar" used in the earlier experiments was exhausted and no equally pure sample could be procured, loaf-sugar being therefore used in the present series. The loss of rotatory power due to dilution of the solution during the opening and closing of the cells was in these measurements finally reduced to zero, preceding series having given losses of 0·20, 0·10, and 0·22 per cent. T. M. L.

1332. *Preparation of Absolute Sulphuric Acid: its Specific Conductivity and that of Dilute Acid.* **D. M. Lichty.** (Amer. Chem. Soc., Journ. 30. pp. 1834–1846, Dec., 1908.)—The author gives a method for preparing relatively large quantities of pure, unpolymerised sulphur trioxide, from which absolute sulphuric acid may be prepared by mixing with the calculated proportion of water. Absolute sulphuric acid exhibits a sharply defined minimum electrical conductivity and a sharply defined maximum freezing-point, on which the preparation of the acid may be based. For determining the strength of sulphuric acid of higher concentration than 95 per cent. the electrical conductivity yields results never seriously more, and generally less, than 0·01 per cent.; a table of specific conductivities is given adapted to this end.

T. H. P.

1333. *Heats of Formation of Anhydrous Oxides of Strontium and Barium.* **de Forcrand.** (Comptes Rendus, 146. pp. 217–220, Feb. 3, 1908.)—The results obtained by the author are as follows: $Ca + O = CaO + 151{\cdot}90$ Cals.; $Li_2 + O = Li_2O + 143{\cdot}32$ Cals.; $Sr + O = SrO + 137{\cdot}60$ Cals.; $Ba + O = BaO + 125{\cdot}86$ Cals.; $Ca + O_2 = CaO_2 + 157{\cdot}83$ Cals.; $Li_2 + O_2 = Li_2O_2 + 152{\cdot}65$ Cals.; $Sr + O_2 = SrO_2 + 152{\cdot}10$ Cals.; $Ba + O_2 = BaO_2 + 145{\cdot}71$ Cals. The heats of hydration of the monoxides are also calculated. T. H. P.

1334. *E.M.F. of Iodine Concentration Cells with One Electrode Saturated with Iodine.* **A. P. Laurie.** (Roy. Soc. Edinburgh, Proc. 29. pp. 304–315, 1908–1909.)—The e.m.f. of iodine concentration cells with one electrode saturated with iodine, as measured by a Dolezalek electrometer, rises from 0·0640 volt in a solution containing 0·025 mol. of KI per litre to 0·1172 volt in a solution containing 1 mol. of KI per litre. From the results obtained the number of free iodine ions is determined in saturated solutions of iodine in KI of varying strengths. In a solution containing 0·5 mol. of iodine per litre the number of free iodine ions present is 0·41 per litre. W. H. Si.

1335. *Oxidation Potentials in Non-aqueous Solvents.* **R. Abegg** and **J. Neustadt.** (Zeitschr. Elektrochem. 15. pp. 264–266, May 1, 1909.)—According to Nernst the formation of a p.d. at unattackable electrodes immersed in oxidising or reducing solutions is due to the fact that the oxidising or reducing agents enter into reaction with the water and liberate oxygen or hydrogen at a definite pressure, thus forming gas electrodes. According to this idea, water or some other medium must be present, which, under the action of oxidising or reducing agents, will evolve a gas which is electromotively active. To test if this is the case the authors have investigated the action of pyridine as a solvent, with which liquid the reversible evolution of a gas cannot be assumed. They find that mixtures of cuprous and cupric chlorides and of ferrous and ferric chlorides give perfectly definite potentials against Pt electrodes, and moreover that, in the case of concentration cells, the alterations in the e.m.f. are in qualitative agreement with the theory. The values for the cupri-cupro and ferri-ferro potentials are found to be approximately the same in pyridine as in water. Thus in pyridine the formation of a potential is very probably not due to the intermediate action of the solvent; the metal of the electrode simply forms the seat of the interchange of the ionic charges of the oxidising and reducing agents. This idea can be extended to aqueous solutions, although it does not follow that for such solutions the explanation of Nernst is incorrect. T. S. P.

1336. *The Oxide Theory of the Oxygen Electrode. IV. and V.* **R. Lorenz and P. E. Spielmann.** (Zeitschr. Elektrochem. 15. pp. 293–297, May 15, and pp. 349–355, June 1, 1909. From the Laborat. f. physikal. Chem. u. Elektrochemie des Eidgen. Polytechnikums, Zürich.)—IV. A continuation of previous work [see Abstracts Nos. 745 and 945 (1909)]. A correction of numbers given in the previous paper is communicated. The present paper contains measurements of the e.m.f. of various platinum salts against a hydrogen electrode. As results, it was found that the different Pt compounds yield slightly different values of the e.m.f. Moreover, when the stage of oxidation of the Pt compound is the same, the e.m.f. depends on the degree of hydration, increasing with increasing hydration. The results thus obtained are in qualitative harmony with the observations of Streintz on lead compounds, and they seem to show that the water is present as a constitutional part of the molecule, as suggested, say, by Werner's theory. Various possibilities of disturbance of the e.m.f., however, exist, and the investigation is being continued. V. The authors have investigated the discharge potential curves of the oxides of platinum, and find that there are no less than ten arrest-points. These arrest-points are explained as being due to different oxides or hydrates. So far as potentials above 0·94 volt are concerned, the explanation for these has not yet been obtained; but it is probable that they also will be explained by the formation of oxides or hydroxides. A. F.

1337. *The Electric Discharge and Production of Nitric Acid.* **W. Cramp and B. Hoyle.** (Inst. Elect. Engin., Journ. 42. pp. 297–338; Discussion and Communications, pp. 338–361, April, 1909. Paper read in London and Manchester, Dec., 1908. Abstracts in Electrician, 62. pp. 383–386, Dec. 18, 1908. Elect. Engineering, 4. pp. 810–812; Discussion, pp. 813–815, Dec. 24, 1908.)—The experimental arrangements of the authors resemble those of Werner. A high-tension transformer coupled with a Cramp self-exciting alternator with a very drooping characteristic, running at 1,200 r.p.m. and giving current at 160 ∿, is directly joined to a pair of ribbon electrodes of phosphor bronze, shaped like horn lightning-arresters; the air blows from underneath into the adjustable spark-gap through a nozzle of the de Laval type, opening out conically. Measurements are mostly made in the secondary circuit, sometimes directly on the high-tension side. As the current increases the discharge passes without any definite break in the volt-amp. curve from glow into brush, oscillating spark, nitrogen flame, and the ordinary arc. The brush and glow give chiefly ozone; high frequency seems to increase the yield of ozone rather than of NO, but the actual frequencies in the surging spark threads may be many times higher than the alternator frequency. The blue oscillatory spark produces ozone (spectroscopic tests) whose lines are absent in the nitrogen flame. The arc thread diam. is estimated at 0·002 cm., and the current density in the gap at $6·6 \times 10^5$ amp./cm.^{2} The authors suggest that ions produced at low potential do not reach the middle of the field, but are called back by the current reversals; at higher potentials the glow and double luminous cone appear, and the velocity of the corpuscles becomes sufficiently high to produce ionisation by collision. With high air velocity (glow or brush discharge) the current is exclusively carried by the oxygen ions; a current which at low velocity yields nitrous gases will produce ozone with increased velocity, and when the discharge is giving NO at high currents, the lower portion of the discharge consists of oxygen. In the *discussion*, **W. Duddell** questioned some of the measurements, and inquired how an arc or other discharge could have two stable conditions corresponding to a definite current, as in the authors' diagram; he also doubted that the blue line indicated an oscillating spark. **G. N. Huntly** referred to the chemical tests. **H. Borns** thought that the authors in their theory approached Warburg and Haber and Koenig, whom their literature list did not mention. H. B.

1338. *Validity of Faraday's Law at Low Temperatures.* **W. G. Wilcox.** (Journ. Phys. Chem. 13. pp. 383–387, May, 1909.)—The author has investigated the validity of Faraday's law at temperatures down to −55° in the case of pyridine solutions of silver nitrate. While the results do not agree exactly at low temperatures, they nevertheless appear to admit of the following conclusions: (1) That the electrochemical equivalent is independent of temperature-change during the course of the electrolysis; (2) that Faraday's law holds for low temperatures, provided secondary changes are taken into consideration. A. F.

1339. *Electrolytic Determination of Manganese.* **C. N. Otin.** (Zeitschr. Elektrochem. 15. pp. 385–386 and 386–389, June 15, 1909.)—While analysing a solution of manganese sulphate, $MnSO_4,4H_2O$, the author noticed that some metallic Mn was deposited on the kathode, and the anode (material not stated) lost 7 per cent. by weight. According to Engels, all the Mn should have been deposited on the kathode as a mixture of oxides. Investigating the observation the author finds deposition of metallic Mn especially in neutral sulphate at high current density; addition of ammonium sulphate to the electrolyte prevents this deposition. This addition has the further advantage that the deposit, when dried at 220°, is anhydrous MnO_2, and not a mixture of oxides. When the ammonium sulphate is replaced by alcohol the deposit contains a small, mostly insignificant, amount of MnO. The method is recommended for dilute solutions of manganese sulphate and nitrate. H. B.

1340. *Wood-Pulp Bleaching with Electrolyte and with Chloride of Lime.* **B. Fraass.** (Zeitschr. Elektrochem. 15. pp. 421–425, June 15, 1909.)—While it is generally acknowledged that better effects are obtained in textile bleaching with electrolytic lye than with chloride of lime, opinions differ widely as to the wood-pulp bleaching. This is partly explained by the great influence of slight differences in the working of sulphite cellulose. The author conducted a large number of comparative experiments with wood-pulps of different origins in enamelled iron crucibles. In all cases except one the bleaching realised was better, for equal amounts of chlorine consumption, with the electrolyte, both in acid and in alkaline lyes. In practice the lye is almost always slightly acid. The alkalinity rather improves than impairs the bleaching effect, but retards the process; strong acidity is injurious. The same bleaching effect can be obtained in acid and alkaline lyes with 5 per cent. less of electrolytic chlorine than of chlorine from chloride of lime. The cause of the superiority of the electrolyte is obscure; the different rates of diffusion of the calcium and sodium hypochlorites are probably concerned. H. B.

REFERENCES.

1341. *A Modified Oxy-hydrogen Gas Coulombmeter.* **J. W. Turrentine.** (Journ. Phys. Chem. 13. pp. 349–354, May, 1909.)—This is the Walter-Neumann single tube coulombmeter, but the Pt wires carrying the electrodes are not fused in the wall of the coulombmeter; they are fused into glass tubes which can then be fixed by means of rubber stoppers in small side tubes at the foot of the apparatus. A. F.

1342. *Temperature-coefficients of Electrical Conductivity of some Acids and Bases in Aqueous Solution.* **A. Wörmann.** (Ann. d. Physik, 29. 1. pp. 194–200, April 22, 1909. Errata, 29. 3. pp. 623–624, June 10, 1909.)—Values are given for the temperature-coefficients of aqueous solutions of NaOH, KOH, HCl, and HNO_3, at concentrations N, N/2, 3N/8, N/4 and N/10; tables are given comparing the author's values with those obtained by Kohlrausch, Jaquerod, Deguisne, and others. T. M. L.

1343. *Table of Molecular Conductivities.* **P. Blackman.** (Journ. Phys. Chem. 13. pp. 144–153, Feb., 1909.)—The author has calculated large tables of molecular conductivities on the assumption that they always obey an additive law [but he does not appear to have checked them against experimental data, and includes values for *e.g.* normal solutions of silver iodide which can only be matters of pure fancy.] T. M. L.

1344. *Hydrates in Solution: A Review of Recent Work.* **E. W. Washburn.** (Jahrbuch d. Rad. u. Elekt. No. 4, 1908. Technology Quarterly, 21. pp. 360–449, Dec., 1908. Contribution from the Research Lab. of the Mass. Inst. of Technology, No. 38.)—A monograph extending over ninety pages, which constitutes one of the most complete and valuable discussions that has yet appeared in reference to the theory of hydrates in solution: the author has taken pains to describe and criticise all the important work that has been done in recent years, and his paper is free from the one-sidedness which is the commonest fault of such publications. T. M. L.

1345. *Time Occupied by Substances in Dissolving.* **G. Gaillard.** (Soc. Franç. Phys., Bull. 3. pp. 203–211, 1908. Journ. de Physique, 8. pp. 182–190, March, 1909.)—Tables are given showing the rate of dissolution of sodium sulphate, thiosulphate, and chloride, potassium chromate, calcium sulphate, sugar, and certain other compounds when in the form of powder and when in coarse crystals. T. M. L.

1346. *Osmotic Phenomena and their Modern Physical Interpretation.* **H. L. Callendar.** (Engineering, 87. pp. 362–364, March 12, 1909. Discourse delivered at the Royal Institution, Feb. 26, 1909. Chem. News, 99. pp. 196–200, April 23, 1909.)

1347. *The Chemist's Relation to the Copper and Brass Industries.* II. **E. A. Lewis.** (Soc. Chem. Ind., Journ. 28. pp. 584–588; Discussion, pp. 588–590, June 15, 1909. Paper read before the Birmingham Section, March 18, 1909.)—An account is given of the methods used by the author for the analysis of various metals, ores, and residuals used in the copper and brass industries. Copper, antimony, and nickel are determined electrolytically, using stationary electrodes. The author finds the estimation of Ni from solutions containing oxalic acid to be satisfactory. The paper has been written with a view to help to get standard conditions in the copper and brass industry. [See also Abstract No. 1327 (1908).] T. S. P.